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Cotton Carding

Cotton Cards, Parts 1-4

By

H. E. REED, B.T.E.

TEXTILE EDITOR, I.C.S. STAFF

UNDER SUPERVISION OF

C. J. BRICKETT

DIRECTOR, SCHOOL OF TEXTILES
INTERNATIONAL CORRESPONDENCE SCHOOLS

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PREFACE

In the preparation of the volumes of the International Library of Technology that deal with textile manufacturing, the desire of persons identified with the industry for pertinent and exact technical information has been constantly kept in mind. Undoubtedly, these texts will be of great value to all who are in any way connected with, or interested in, the manufacture of textiles, but the detailed instruction has been prepared specifically for teaching those who actually are engaged in the spinning of yarns and the designing and weaving of fabrics in textile mills. It is hoped, therefore, that these books will not only prove useful to busy mill executives and others for ready reference, but that they will also be of exceeding value for study to all who are actively engaged in the practical work of textile establishments.

As reference works, these volumes should enable many perplexing problems to be solved quickly and in an authoritative manner. As textbooks for study, they should serve to impart an accurate knowledge of manufacturing operations and processes to those who are most vitally concerned. In the latter case, the library will prove most helpful to the many textile workers who wish to improve their understanding of the machines and processes incident to operations included in the practical work of the department of the mill or branch of the textile industry with which they are identified. Moreover, many persons engaged in textile work are unfamiliar with any phase of textile manufacturing except the work of the department of the mill in which they are employed. Thus, those who are engaged in weaving may know nothing of spinning, carders may be unfamiliar with the work of spinners and weavers, superintendents may have a practical knowledge of only a single department, and so on. To all such, the study of textbooks relating to other branches of textile manufacturing has a distinct broadening influence that is exceedingly valuable to those in executive positions involving contacts with the work of a number of departments.

The technical information contained in these volumes is intensely practical, and the text has been carefully written so that facts and explanations may be readily grasped by those who

are, or who are not, technically trained. A special effort has been made to treat all subjects completely from elementary to advanced stages, but explanations and descriptions have been made as concise as possible, consistent with a thorough treatment of the wide range of subjects. In describing a process, or the construction and operation of a machine, or method of performing necessary calculations, and the like, the subject is dealt with step by step so that there is no possibility of ambiguity. Illustrations have been used most generously, and have been employed whenever and wherever they serve to enhance the clearness of the text. Perspective drawings, plans, elevations, sections all have been employed and all have been drawn especially for these texts. Color has been employed in illustrations where it adds to the lucidity of explanations.

In this textbook, a complete treatise on cotton cards and cotton card-room operations is presented to the student. Subjects relating to the construction and operation of cotton cards, including all necessary calculations, have been dealt with in a logical order of sequence. All card settings have been explained; card clothing and the clothing of the various parts of a cotton card have been described; stripping, including not only usual methods, but continuous and vacuum stripping systems as well, has been fully treated, and waste tests, sliver testing, carding staple rayon, and many other matters have received adequate attention.

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CONTENTS

NOTE.—This book is made up of separate parts, or sections, as indicated by their titles, and the page numbers of each usually begin with 1. In this list of contents the titles of the parts are given in the order in which they appear in the book, and under each title is a full synopsis of the subjects treated.

COTTON CARDS, PART 1

COTTON CARDS, PART 2

COTTON CARDS, PART 3

COTTON CARDS, PART 4

COTTON CARDS

(PART 1)

INTRODUCTION

1. The lap of cotton as it leaves the picker consists of cotton fibers crossed in all directions, together with a small amount of foreign matter, consisting more especially of lighter impurities such as pieces of leaf, seed, or stalk, and thin membranes from the cotton boll. Such material is of too light a nature to be removed by the action of the beaters or to drop through between the grid or inclined cleaning bars of the pickers, so that it is carried forwards with the cotton and into the lap. In order to remove this foreign matter, machinery of an entirely different character from the cleaning machinery previously used must be adopted, and for this purpose the cotton card is employed, the process being known as carding. Carding is regarded by many manufacturers as one of the most important processes in cotton-yarn preparation. In addition to cleaning the cotton, it is also the first step in the series of attenuating processes, which gradually reduce the weight of cotton per unit of length sufficiently to form a thread. The lap from the picker is comparatively heavy, and must be reduced considerably in weight at various machines in order to give the weight per unit of length required in the yarn. The carding process is the one that follows the picking operations in all cotton mills, whether coarse or fine, and whether making carded or combed yarns.

2. Objects of Carding.—The objects of carding are: (1) The disentangling of the cotton fibers, or the separation

of the bunches, or tufts, of fiber into individual fibers, and the commencement of their parallelization; (2) the removal of the smaller and lighter impurities; (3) changing the formation of cotton from a lap to a *sliver*, accompanied by the reduction of the weight per yard of the material. A **sliver** is a round, loose strand of cotton without, or almost without, twist, and usually from 40 to 80 grains per yard in weight. It is generally coiled in a can, and is made at the carding, drawing, and combing processes.

3. Principles of Carding.—In order to arrive at the previously mentioned objects, the principle of combing the fibers between sets of closely arranged wire teeth is adopted; one set may be fixed and the other moving, or each set may be moving in the opposite direction to the other, or both may be moving in the same direction but at different speeds. In any case, the sets of wire teeth are in close proximity to one another. The first and second objects—the disentangling of the cotton fibers and the removal of the impurities—are attained by this means, as the fibers forming the small tufts are drawn apart and the lighter impurities are caught between the wires, where they remain until removed by special means. Use is also made of the centrifugal force of a cylinder covered with wire teeth and revolving at a high speed in attaining the first and second objects of carding; the ends of the fibers are thrown against stationary or moving points of wire and the fibers thus combed out, while heavier impurities such as sand, dirt, and dust are thrown out, owing to the high speed of the cylinder. Another method of arriving at the second object is that of arranging knives or bars partly around the revolving portions of the card, to clean and throw off the dirt, sand, and dust from the fibers as they are drawn past such obstructions. ȶ The third object is attained by adopting the principle of drafting, the attenuation of the material being produced by revolving cylinders covered with wire teeth, instead of by the usual method of rolls, which are used in this machine only at the feed and delivery.

Carding is really a combing or brushing action, the fibers being operated on by a series of wire teeth, which has the same effect as loosely holding a few fibers at a time and striking them with a comb; the process, however, must not be confused with that technically known as *combing*, which is an entirely separate process and used only in the manufacture of fine yarns. The machine employed in carding is usually spoken of as a *card*, or sometimes as a *carding engine;* this latter name, however, is used more commonly in England than in the United States.

CARD CONSTRUCTION

THE REVOLVING-TOP FLAT CARD

PRINCIPAL PARTS

4. The **card** that is most commonly used and now almost universally adopted for new cotton mills is known as the **revolving-top flat card**, sometimes spoken of as the *revolving flat card*, or the *English card*. Views of it are shown in Figs. 1 and 2, Fig. 1 showing one side of the card, with the machine in condition for operation, while Fig. 2 shows the other side as it is seen when stopped and without any stock passing through. A section through the same card from back to front is shown in Fig. 3. The various parts of the card are lettered the same in all three figures, and reference letters should be referred to on Fig. 3 especially; but it is also advisable to refer to Figs. 1 and 2 for the same parts, in order to identify them and ascertain their relations to one another. The same letters are used in other figures throughout this Section in accordance with the following list. All parts of a single motion or section of the card are designated by the same letter, which in some instances is followed by a figure, known as the *subscript*, to distinguish the particular part for which it is used from related parts having the same reference letter.

FIG. 1
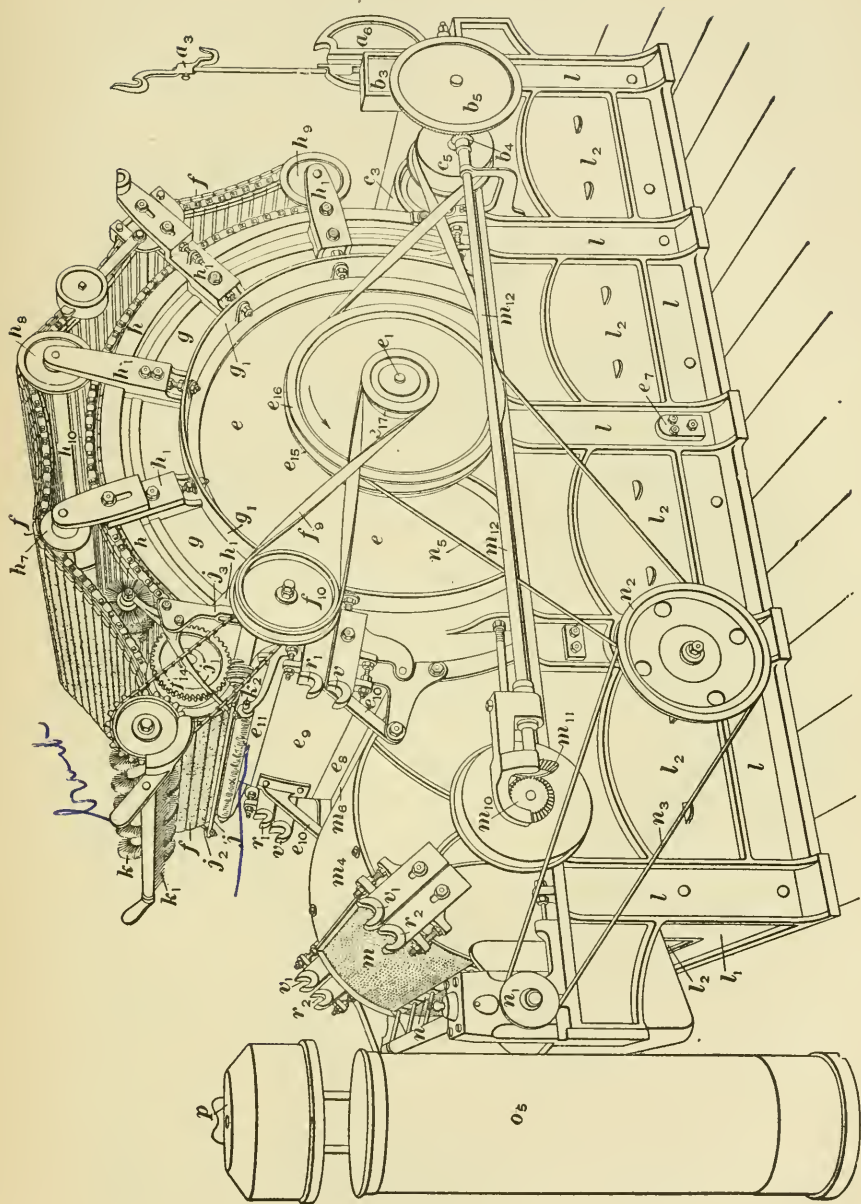
FIG. 2
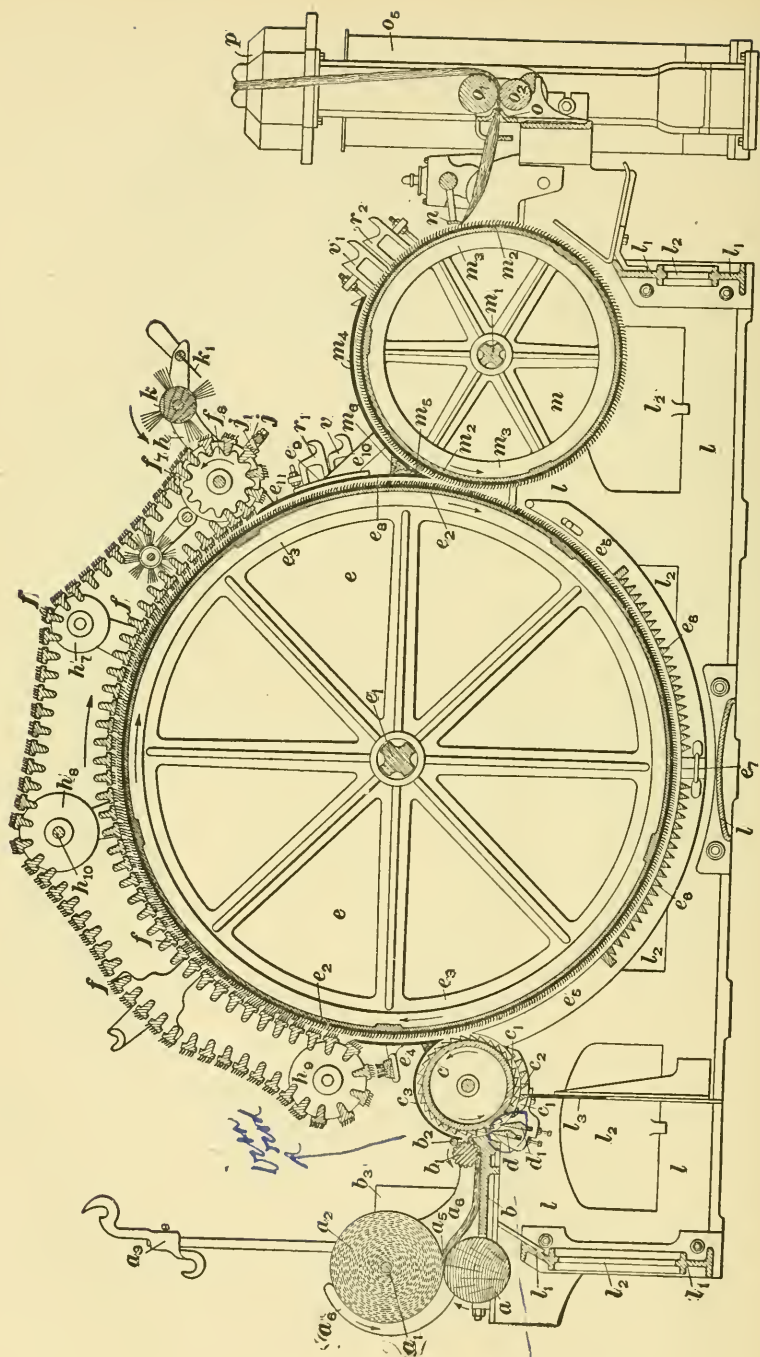
FIG. 3

5. The principal parts of the machine are as follows:

a, Lap roll.

a_2, Lap that is being carded.

a_4, Spare lap.

a_5, Lap plates.

b, Feed-plate.

b_1, Feed-roll.

b_3, Weights for feed-roll.

c, Licker.

c_1, Licker screen.

d, d_1, Mote knives.

e, Cylinder.

e_4, Back knife plate.

e_5, Cylinder screen.

e_9, Lower front plate.

e_9, Door at front of cylinder.

e_{11}, Front knife plate.

e_{12}, Tight pulley on cylinder.

e_{13}, Loose pulley on cylinder.

f, Flats.

g, Arches of card.

h, Flexible bend on which a portion of the flats rests.

h_7, h_8, h_9, Pulleys for supporting flats.

j, Flat-stripping comb.

k, Flat-stripping brush.

k_1, Hackle comb for cleaning flat stripping brush.

l, Card sides.

l_1, Cross-girts.

l_2, Doors in frame of card.

m, Doffer.

m_4, Doffer bonnet.

m_9, Barrow gear.

m_{12}, Side shaft.

n, Doffer comb.

o, Trumpet.

o_1, Top calender roll.

o_2, Bottom calender roll.

o_5, Can in which sliver is coiled.

p, Cover of coiler.

p_1, Coiler calender rolls.

Figs. 4 and 5 show a revolving flat card of another style of construction, but all essential parts are the same and are lettered as in Figs. 1, 2, and 3.

6. Feed-Roll and Feed-Plate.—At the back of the card in Fig. 1 is shown the lap a_2, which has a rod a_1 passed through its center and rests on the lap roll a, shown in Fig. 3. The lap a_2 is the one being carded, a spare lap a_4 being shown above it in Fig. 1, resting in a s.and a_3. The lap roll a is constructed of wood and is either fluted or has a rough surface, sometimes produced by covering it with a coat of paint mixed with sand, in order to cause the lap to unroll by friction with the lap roll and without any slippage.

The cotton is drawn over the feed-plate b, Fig. 3, by the feed-roll b_1, the single layer, or sheet, leaving the lap at the
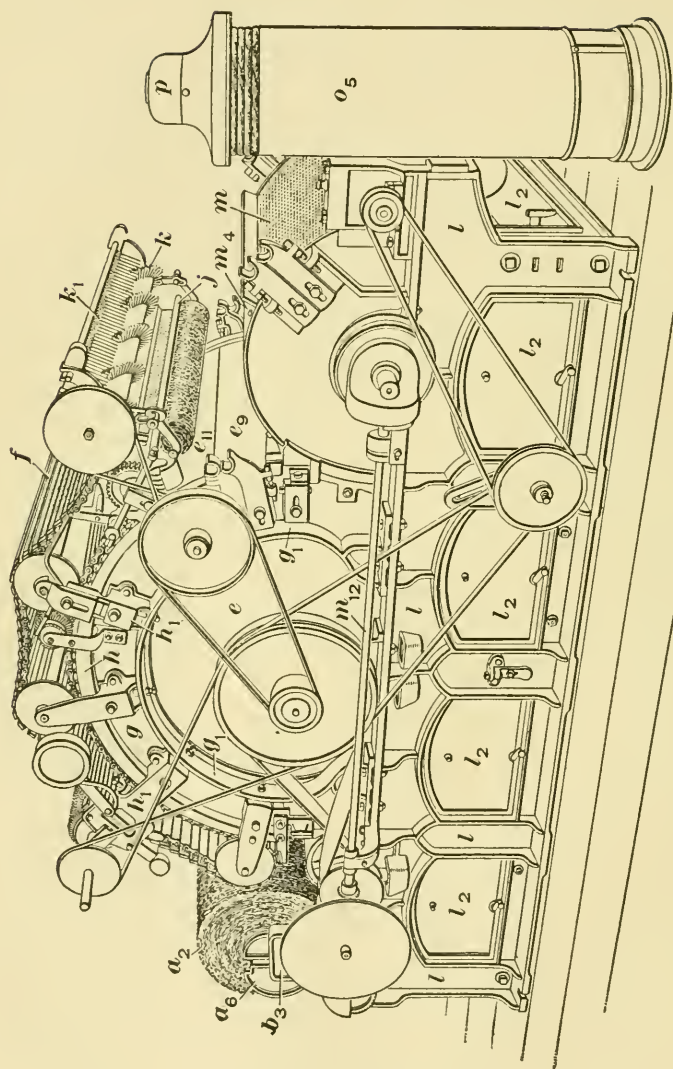
FIG. 4

point a_5. As it passes from the lap to the feed-roll, each outer edge of the sheet comes in contact with a lap guide—a wedge-shaped piece of metal bolted on the inside of the
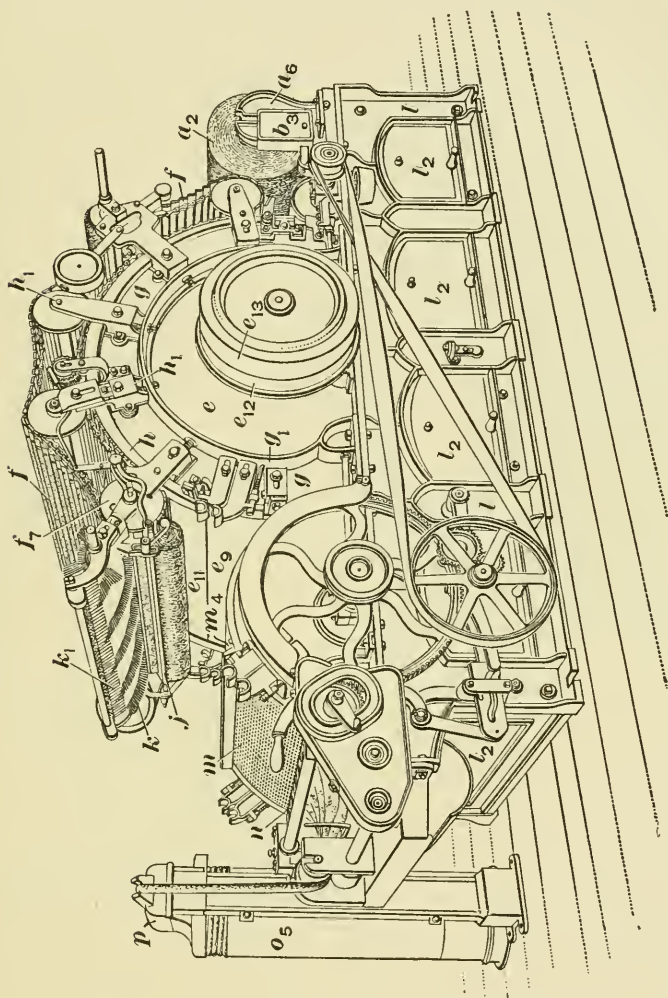
Fig. 5

plate a_6. This guide turns up the edges of the sheet to a small extent, making it slightly narrower as it approaches the feed-roll. This tends to prevent the outer edge of the

cotton from spreading and producing a ragged edge. The feed-plate b extends under the feed-roll b_1, with its nose projecting upwards in front of the feed-roll almost to the teeth shown on the circumference of the licker c. The feed-roll b_1, which revolves in the direction indicated by the arrow, is fluted longitudinally and is sufficiently large in diameter to resist any tendency to spring or bend when a thick piece of cotton passes beneath it. Its ends rest in slides and it is weighted at each end by means of a weight b_3, Figs. 1 and 2, on a lever that has, as a fulcrum, a lug on the feed-plate. The lever has a bearing on a bushing on the feed-roll and thus produces the pressure of the feed-roll on the sheet of cotton on the feed-plate, the extent of which may be regulated by moving the weight b_3 along the lever. If the pressure is too light, the action of the licker will pull the cotton from the feed-roll before it should be delivered. This is known as *plucking*, and results in cotton being taken by the licker in large and tangled flakes that have not been opened, thus causing un-
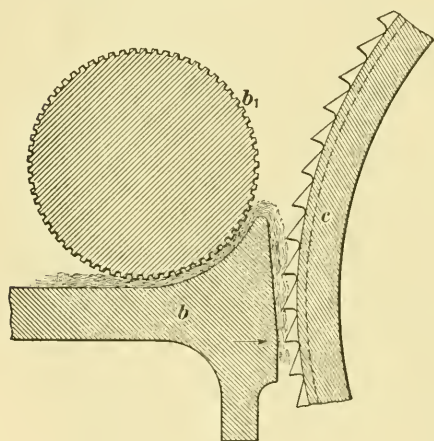
Fig. 6

even work and requiring the finer parts of the card to perform the heavy work, which should be done by the licker.

Above the feed-roll rests a small iron rod b_2 that is revolved by frictional contact with this roll and, since it is covered with flannel, collects any fiber or dirt that may be carried upwards over the surface of the feed-roll and thus acts as a clearer. It also serves to prevent any air-current from passing between the feed-roll and the licker cover.

The lap roll a is positively geared with the feed-roll b_1 in such a manner that the feed-roll takes up the lap delivered

by the lap roll, without unwarranted strain and without sagging, and as it revolves, carries this cotton over the nose of the feed-plate so that a fringe is brought under the action of the licker c in the man-
ner shown in Fig. 3, and on a larger scale in Figs. 6, 7, 8, and 12. The upper end of the nose of the feed-plate is rounded so as not to damage the cotton resting on it and pressed against it by the action of the licker.
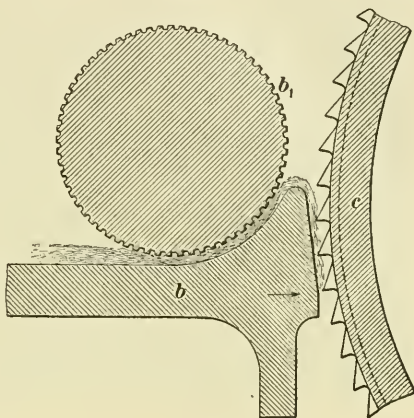
FIG. 7

7. The important difference in various feed-plates is in the distance from the bite of the feed-roll to the lower end of the face, indicated by the arrow in Figs. 6, 7, and 8. By regulating this distance in accordance with the length of staple being worked, the entire length of
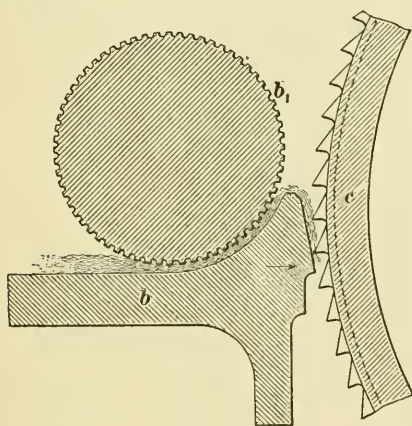
FIG. 8

staple is so supported that it receives the full benefit of the cleaning and disentangling action of the licker, which reduces the work on the finer parts of the card. The distance between the bite of the feed-roll and the lower edge of the face of the feed-plate should be from $\frac{1}{16}$ to $\frac{1}{8}$ inch longer than the average length of the cotton being worked, as it is necessary that the fibers should be free from the bite of the feed-roll before the action of the teeth of the licker exerts its greatest pull, which

is at the lower edge of the plate; otherwise, the fibers would be broken. The fringe of cotton is shown in Fig. 9. The feed-plate shown in Fig. 6 is suitable for sea-island cotton, as it has a face that makes it possible for the long fibers to hang down; the feed-plate shown in Fig. 7 is the style common-ly used in America, being adapted for the various grades of American and Egyptian cottons. A feed-plate with a shorter face, as shown in Fig. 8, is sometimes made for very short-stapled cottons, such as those grown in India and China.
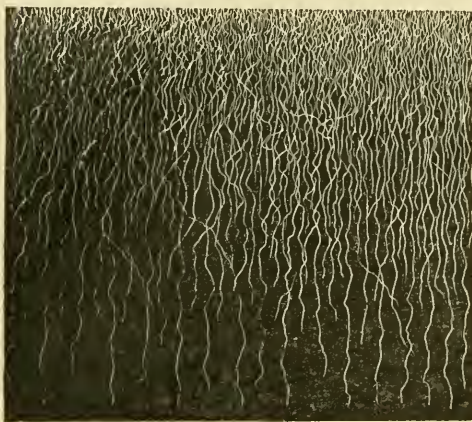
Fig. 9

8. Two-Roll Method of Feeding.—Some cards, instead of having the feed-roll and feed-plate, are constructed so as to feed the licker by means of two feed-rolls, as shown in Fig. 10. This is an older form of feeding and is not so desirable. The disadvantage of this method is that a fourth of the diameter of the lower feed-roll is covered with loose cotton before it
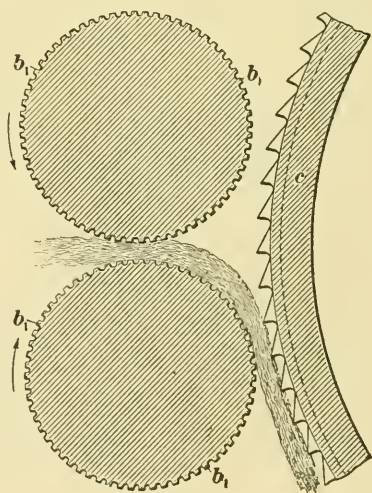
Fig. 10

reaches the point where it comes under the action of the teeth of the licker, thus tending to increase the possibility

of the licker plucking large tufts of cotton before the cotton ought to be delivered. This system is also inferior on account of the brief opportunity given for the licker to operate on the fringe of cotton, as compared with the roll and feed-plate system, where a long fringe of cotton is presented to the licker, thus giving a much better opportunity for combing and removing the dirt. In fact, the combed fringe of cotton in a card using the feed-plate can be arranged to be about three times the length of that in a card using the two-roll method of feeding.

9. Licker.—The object of either of these feeds is to feed a regular supply of cotton to the licker c, shown in

(a)   (c)

(b)
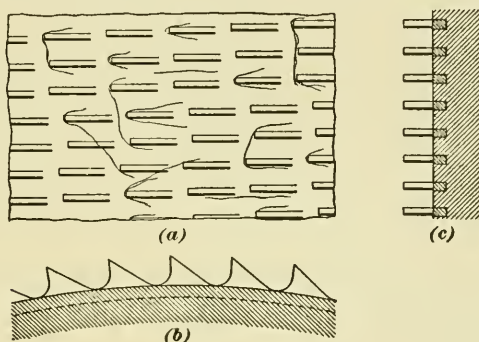
Fig. 11

Fig. 3, sometimes called the *leader, taker-in*, or *licker-in*. The licker consists of a hollow metal roll about 9 inches in diameter. On the outside of the shell, or curved part, of the roll, and extending from one end to the other, are spiral grooves into which rows of teeth are inserted. Fig. 11 (*a*) is a view of the teeth of the licker as they appear when looked at from above, and also shows the fibers being carried by them from the feed-roll, thus indicating the manner in which the lap of cotton is separated almost into individual fibers by the operation of the licker, which revolves so rapidly, compared with the amount of cotton delivered, that about 2,000,000 teeth pass the nose of the feed-plate while 1 inch of cotton is being delivered. It will be

seen from Fig. 11 (*a*) that the teeth are scattered, or *staggered*, over the shell of the roll in consequence of the spiral arrangement, and thus one tooth does not strike the fringe of cotton exactly where the previous one struck.

Fig. 11 (*c*) is a section of a portion of a licker showing the construction of the wire from which the teeth are formed, and also the method of fastening it securely in the roll. The teeth are punched out of a narrow, flat, strip of steel, or wire, carrying a thickened rib along one edge. This rib is forced into the grooves prepared in the shell of the licker, and the teeth project, as shown in Fig. 11 (*b*), the dotted line indicating the depth to which the rib is sunk into the shell of the licker. Several separate spirals are laid side by side, the distance between two rounds of any one spiral being 1 inch, and there are either five, six, seven, eight, nine, or ten spirals side by side, according to the class of work for which the card is intended. This results in the distance between the centers of two consecutive spirals being either $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$, or $\frac{1}{10}$ inch apart, while the points of the teeth are usually $\frac{1}{4}$ inch apart lengthwise of the wire.

The shell of the licker *c* is shown in section in Figs. 3 and 12, which also show the relative position of the licker to the contiguous portions of the card. Below the feed-roll b_1, clearer b_2, and feed-plate *b* are seen the sections of two knives d, d_1, which are known as **mote knives.** These knives extend across the card in the position shown, with the blade of the knife near the teeth of the licker; their object is to remove such impurities as hulls, husks, bearded motes, etc., or in other words, all portions of matter other than cotton.

At the nose of the feed-plate, the licker is moving in a downward direction and the teeth are pointing in the direction of its revolution. Since the fringe of cotton is held by the roll, it will be disentangled as the teeth pass through it. When the cotton is released from the bite of the feed-roll, it will be taken by the teeth of the licker. Any short fibers, however, that are not sufficiently long to be secured by the licker, will fall through the space between the mote knives.

The cotton that drops in this manner is known as **fly**, and its ioss is beneficial since it leaves the cotton that passes forwards in a more uniform condition as regards its length of staple.   The licker has a surface speed of about 1,000 feet per minute, and thus, as it revolves with the cotton, the portions of the fibers that are not in contact with the teeth will be thrown out by centrifugal force, so that the impurities that project from the fibers on the surface of the licker will
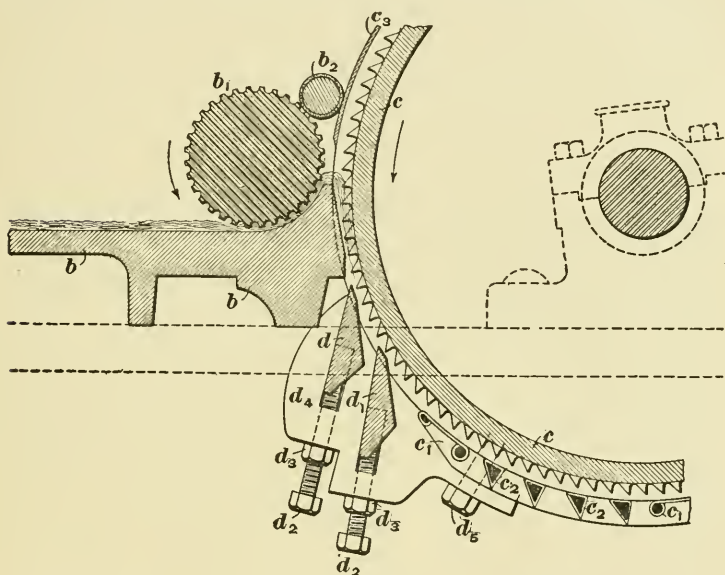
Fig. 12

come in contact with the blades of the mote knives and be removed, dropping into the cavity below the knives.

In the usual construction of cards there are two of these mote knives, although one may be used.   The knives are rigidly held in suitable supports, and in the style under consideration their correct angle is decided by the machine builder, the arrangement being such that this angle cannot be changed.   They are sometimes, however, made adjustable, either by being placed in a swinging frame or, as in Fig. 12, by being provided with setscrews d_2 and locknuts d_3, by

means of which either knife may be moved closer to or farther from the licker and then locked in position; or the entire bracket d_4 that carries both knives, may be moved farther from or closer to the feed-plate by loosening the screw d_5, sliding the entire bracket d_4 on the frame of the licker screen, and then relocking it.

10. Licker Screen and Licker Cover.—Underneath the licker is a casing c_1 known as the **licker screen.** This casing, which is shown in Figs. 3 and 12, is made of tin and extends across the card. The portion of the screen directly under the licker is composed of transverse bars c_2, triangular in shape with rounded corners and set with their bases inverted, the remainder of the screen being plain metal. As the licker revolves, whatever heavy impurities were not previously taken out will be thrown through the openings in the screen, due to the action of centrifugal force. The cotton will also come in contact with the screen as it did with the mote knives, and thus additional impurities will be removed.

The top of the licker is protected by a metal cover c_3 known as the **licker cover,** or **bonnet,** which is curved to correspond to the curved surface of the licker. This cover is held in position by two disks, one at each end, through which the shaft of the licker projects. These disks are held in position by flanges attached to them, which rest in the licker bearings attached to the framework of the card. The licker cover is screwed to these disks, and thus the licker is completely enclosed. The points where the shaft passes through the disks should be kept clean and well oiled; otherwise, the points of contact will become heated and tend to bind the shaft.

11. Card Cylinders.—Situated about midway between the back and front of the card, and a prominent feature in its construction, is the cylinder e, mounted on the shaft e_1. This cylinder is usually 50 inches in diameter, while its width depends on the width of the card, being usually 36, 40, or 45 inches. Formerly card cylinders were made of wood, but it is now the universal practice to construct them of cast iron,

as metal resists the changes of temperature and humidity better than wood, which is liable to warp and twist and thus prevent accurate setting of the card. When metal cylinders were first used, the shell e_2, Fig. 3, was constructed in two pieces, which were bolted together, but the best and most modern method is to make the shell in one casting, with a sufficient number of longitudinal and sectional ribs on the interior of the shell to make it strong and rigid. This shell is mounted at each end on a spider e_3, which consists of a heavy rim cast in one piece with a series of strong supporting arms. The hubs of the spiders are accurately bored for the reception of the shaft of the cylinder, while the rims are turned to a true shape and size and accurately fitted to the ends of the shell.

The cylinder should be mounted on its shaft as rigidly as possible, to avoid the possibility of its becoming loose. The method adopted in the card under consideration is as follows: A shaft long enough to pass through the shell and project sufficiently beyond to rest in the bearings and also carry the necessary pulleys for driving the cylinder and various parts of the card is forced into its position through the hub of each of the spiders by means of a powerful screw press. It is then secured to the spiders by means of two large taper dowels, one at each end of the cylinder. These dowels are driven into holes drilled through the hubs of the spiders and through the shaft.

The complete cylinder should be turned and afterwards ground while resting on its own bearing, not on a mandrel, so as to produce an absolutely true surface when in operation. As these cylinders are intended to run at a high speed, they are also balanced so as to insure even running, and when their construction is complete the ends are cased in with sheet iron to prevent dust or fiber from entering the cylinder and to avoid accidents that would be liable to result if they were rotated at a high speed with uncovered arms. In Figs. 1 and 2, the letter e applies more directly to these end casings, although it is used to indicate the cylinder as a whole.

The surface of this cylinder is covered with card clothing, which is a fabric with teeth embedded in it and projecting through it at an angle. The addition of the clothing to the cylinder increases its diameter to about $50\frac{3}{4}$ inches. Reference to Fig. 3 shows the teeth on the surface of this cylinder pointing in the direction of its motion, as indicated by the arrow shown on the shell of the cylinder. A point on the surface of the cylinder travels about 2,150 feet per minute. The teeth of the wire are set very closely in the fabric, there being about 72,000 points to the square foot and more than 3,000,000 points on the entire cylinder. A fuller description of this clothing, together with the manner in which it is applied, is given later.

12. The description of the licker and its operation on the cotton has been carried far enough to explain how the heavier impurities are removed from the fringe of cotton projecting over the feed-plate and driven downwards into the space beneath the card, and also how the fibers are removed from this fringe when they project downwards sufficiently to be released and are carried along on the ends of the teeth of the licker at a speed of about 1,000 feet per minute. These fibers are now transferred to the surface of the cylinder, which is rendered possible by the respective directions of motion of the cylinder and licker and by the direction in which their teeth are pointing. At the point where the licker and the cylinder almost come in contact, both are moving in the same direction and have their teeth pointing upwards. The teeth on the licker are comparatively coarsely set, while those on the cylinder are finely set and have a much greater tendency to hold and to retain the minute fibers than the teeth of the licker. The cylinder is also revolving at more than double the surface speed of the licker, and consequently the fibers are swept off the surface of the licker where the surfaces of the licker and cylinder are in closest proximity and carried upwards on the surface of the cylinder.

Fig. 13 shows the relative positions and the respective styles of construction of the licker and the cylinder at the

point where they approach each other, while Fig. 14 shows an enlarged view of the teeth.

In Figs. 3 and 13, a metal plate designated as a *cover* is shown in connection with the licker cover. This cover e_4, which is known as the **back knife plate**, protects the cylinder at this point and prevents an air-current from being formed by the motion of the cylinder. A wedge-shaped piece of wood c_4 covered with flannel is usually placed in the receptacle formed by the junction of the licker cover with the back knife plate, in order to prevent any possible chance of an air-current.
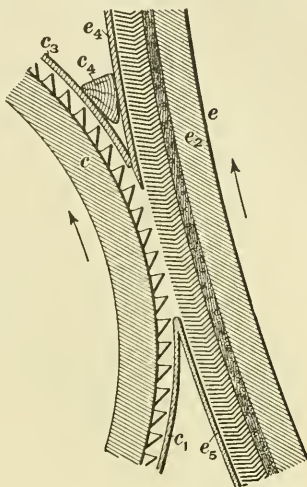
Fig. 13

13. Flats.—Above the cylinder and partly surrounding its upper portion is a chain of flats f, as shown in Figs. 1, 2, and 3. These are the parts that give the name *revolving-top flat card* to the card. They are made of cast iron, approximately **T**-shaped in section, and are partly covered with card clothing about $\frac{15}{16}$ inch wide. They are usually $1\frac{1}{8}$ inches wide and slightly longer than the width of the cylinder, but are covered with clothing only over the
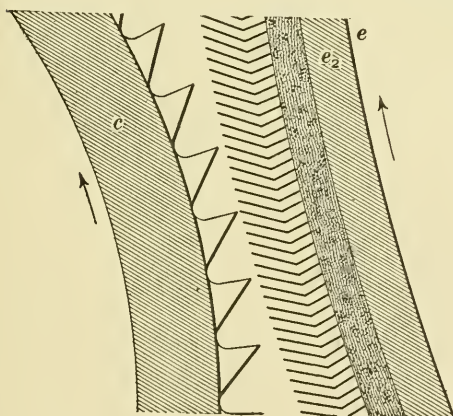
Fig. 14

portion of their length that corresponds to the width of the cylinder. This clothing is of a finer wire, with the teeth more

closely set, than that on the cylinder, and is usually fastened
to the flat by clips on each side of the flat.   There are from
104 to 110 flats on a card, but as they are in proximity to the
cylinder for only about one-third of its circumference, only
from 39 to 43 flats are presented to the cylinder at one time.
Fig. 15 (*a*) gives an end view of a flat, while (*b*) shows a
section.   Each end is drilled and tapped to receive a set-
screw, which passes through a hollow stud carrying links,
and as each link extends from one flat to the next and each
end of each link encircles
one of these hollow studs,
the flats are connected in
an endless chain.   The
screw that is inserted is of
special construction, right-
hand screws being used on
one side of the card and
left-hand screws on the
other, so that the motion
of the flats will tend to
tighten rather than to
loosen the screws and thus
avoid the possibility of
their becoming loose and
allowing a flat to come in
contact with the cylinder,
which would cause con-
siderable damage.
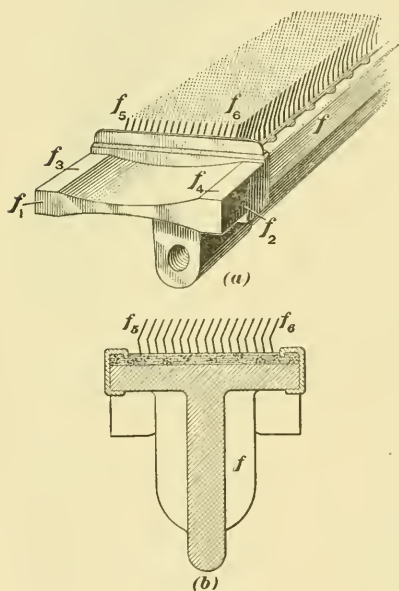
Fig. 15

The flats must be so ar-
ranged that they will be supported immediately above the
cylinder without coming in contact with it or without their
supports interfering with its rotation.   This is done by
means of two arches *g*, Figs. 1 and 2, which are strongly
constructed castings resting on the framework of the card,
one on each side, and securely bolted to it.   Each arch
carries five brackets h_1, which are composed of several
pieces.   One portion of each bracket projects upwards suf-
ficiently to carry a pulley that serves as a support for those

flats that are not performing any carding action and that
are passing backwards over the cylinder, while another
portion of each bracket serves as a support for the flexible
bend h and provides a ready means of adjusting it in order
to move the wire teeth of the flats that are at work nearer to
or farther from the wire teeth on the surface of the cylinder.
A fuller description of the arrangements for adjusting the
flexible bends will be given in the description of setting cards;
it is sufficient to state here that the flexible bends can be
moved farther from, or nearer to, the cylinder shaft at any
one of five setting points on either side of the card, and by
this means the upper edges of the bends can be adjusted so
as to be practically concentric with the circumference, or
wire surface, of the cylinder.

About forty of the flats rest on the flexible bend at each
side of the card; the portions that are in contact with the
oends are the two surfaces f_3 and f_4, Figs. 15 and 16. The
chains are placed as near the flexible bends as possible, since
if they are too far away, the pull and weight of the chains
will cause a deflection in the flat. It is absolutely necessary
that the chains on each side shall be exactly alike and work
with the same tension, as the smallest variation will pull the
flats out of their proper positions over the cylinder, and their
accuracy will thus be destroyed. Chains are now so made
that the whole variation from the standard is not more than
$\frac{1}{50}$ inch. The flats are, of course, linked together on each
side of the card by an exactly similar arrangement, except
that, as has been previously stated, left-hand screws are used
on one side and right-hand screws on the other.

14. Another representation of flats at work .is given in
Fig. 16, which shows them resting on the flexible bend, and
held so that the points of the wire on their surfaces are
almost touching the points of the wire on the cylinder. The
exact distance between the wire on the flats and that on the
cylinder is adjustable, and is usually about $\frac{10}{1000}$ inch. The dis-
tance between the wires, however, is not the same at each
point in the width of the flat, as will be seen by referring

to Fig. 16. The wire of the flat at the point f_5 is closer to the cylinder than at the point f_6 in each case. The end view of the flat in Fig. 15 (a) shows that the metal composing the flat end is cut away more on the side f_1 than on the side f_2; consequently, when this flat is turned over and rests on the flexible bend, the side f_1 will drop closer to the cylin-
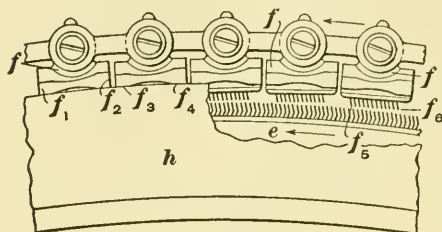
FIG. 16

der than the side f_2, and the wires on the side f_5 will drop lower than the wires on the side f_6, thus making a slightly wedge-shaped space between the wires of the flat and the wires of the cylin-

der. The side f_5 of the flat, which is nearer to the cylinder, is known as the heel, while the side that is farther from the cylinder, namely, f_6, is known as the toe. Flats are always constructed with this heel-and-toe formation, and it should be preserved throughout the life of the card.

The chain of flats is not stationary, but moves at a very slow speed, those flats nearest the cylinder moving toward the front of the card, while of course, the flats that are not working are carried backwards over the top of those that are at work. The means of imparting motion to the flats, which will be described in connection with the gearing of the card, results in a steady, smooth movement usually at the rate of about 3 inches per minute, although this may be changed to either a faster or slower speed, according to whether it is desired to remove more or less waste, respectively, from the cotton. The object of giving a movement to the flats is to carry toward the front of the card those flats that have become filled with impurities, so that they may be stripped and brushed out before they become too full of leaf and other foreign matter to perform the duty of carding the cotton.

15. The method of supporting the flats that are not at work is shown in Figs. 1, 2, and 3. They are supported at

the front by two pulleys f_7, one at each end of a shaft that has its bearings in two brackets, one on each side of the card. On the same shaft with these two pulleys are two sprocket gears, the one shown being marked f_8, the teeth of which mesh with the ribs on the back of the flats, and as this shaft is driven by means of worms and worm-gears, the sprocket gears drive the flats. The portion of the chain of flats directly above the cylinder and resting on the flexible bends revolves in the same direction as the cylinder, namely, toward the front. The flats that are not at work move backwards, in the opposite direction to the cylinder, and rest on pulleys h_7, h_8, h_9 supported by brackets h_1 attached to the arch of the card and duplicated on each side. The ends of the flats rest on these pulleys and impart motion to them by frictional contact. Two of these pulleys h_8 at about the center of the card are connected by a shaft h_{10} that extends across the card. The pulleys h_9, which are directly over the licker, form the turning point of the flats. Those that have been cleaned and carried along over the top turn and pass over the cylinder to perform their work, while those that have just finished their work, being charged with impurities, pass around the pulleys at the front and are cleaned. The bracket h_1, which supports the pulley h_8, is so constructed that the pulley may be raised or lowered to take out the sag, or slack, in the chain of flats or to allow sufficient slack for the flats to revolve freely.

16. As previously explained, the cotton is transferred to the face of the cylinder from the licker at the point where the two surfaces nearly touch each other, and is carried upwards and forwards by it until brought to the point where the flats and cylinder are brought into close proximity. When the cylinder reaches the first flat, the cotton on its surface has a tendency to project from it on account of the centrifugal force of the cylinder, and comes in contact with the teeth at the toe of the first flat. The stock is gradually drawn through the teeth of the flat, receiving more and more of a combing or carding action, until the heel of the flat is

reached, where the teeth of the flat and the cylinder are in the closest proximity, and where the cotton consequently receives the greatest carding action.

Some of the fibers that have not projected sufficiently may not have received any carding action, and the cylinder carries them forwards to the next flat. Those fibers that have been carded once may be carded again, with such additional fibers as are brought under the action of the succeeding flat, and so on throughout the entire series. The flats are set a little closer to the cylinder at the front, or delivery end, than at the back, or feed, end, of the card, and this method combined with the heel-and-toe arrangement of the flat insures a gradual and effective carding of all the fibers before they have passed under the last flat. The small impurities are left behind, since they are forced between the teeth of the wire on the flats or cylinder and remain there until the wire is cleaned, or stripped, as will be explained later. Thus the short fibers and impurities are retained, while the long, clean fibers are passed forwards.

17. Flat-Stripping Combs.—At the front of the card in Figs. 1, 2, and 3 is shown a comb j supported by two arms j_1, j_2. This comb consists of a thin sheet of steel attached to a shaft and having its lower edge made up of fine teeth. It is capable of adjustment so as to be moved closer to, or farther from, the wire on the flats. The comb is given an oscillating motion by means of a cam acting on the arm j_2, Fig. 2, and at each stroke strips from a flat a portion of the short fiber, leaf, and other impurities that adhere to its face. With the arrangement shown in Figs. 1 and 2, a close setting between the comb and flats is not possible owing to the difficulty in giving a backward movement to the comb without damaging the clothing of the flats.

Fig. 17 (a) represents a method of actuating the comb j that differs somewhat from that adopted on the card shown in Figs. 1 and 2. Fig. 17 (b) is a front view of the comb j with bearing j_4 and actuating lever j_5. This comb has two motions; namely, an oscillating motion, which it receives

through the arm j_3 from the cam j_4, by letting the arm j_1 swing around the point j_7 as a fulcrum, and a turning motion in its bearings j_5, received through the lever j_8 from the cam j_6. The teeth of the flats f are stripped while they are pointing downwards by a downward stroke of the comb, governed by the cam j_4. As the comb lifts, it is traveling in a direction opposite to that in which the teeth are pointing, and to prevent injury to the wire the comb is turned away
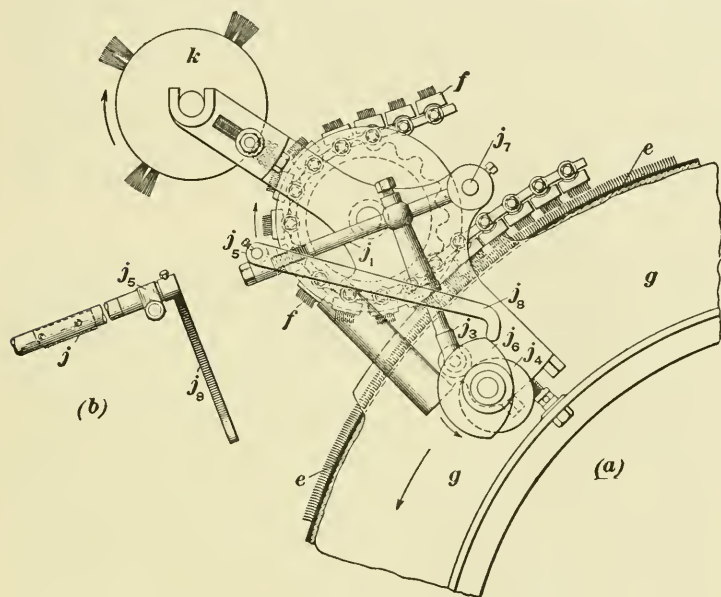
FIG. 17

from the flats by means of the cam j_6. By the use of this arrangement, a closer stripping action is obtained without damaging the wire.

18. Brush.—After the waste, known as *flat strippings*, has been removed by the comb j, the flats are brushed out by means of the brush k, shown in Fig. 17 (*a*) and also in Figs. 1, 2, and 3. This brush consists of a wooden barrel around the surface of which bristles are inserted in four spiral coils, the bristles being long, for a short distance at each end

in order to brush the ends of the flats, and shorter in the middle so as to just reach into the wire of the flat clothing. It is possible to adjust the position of this revolving brush so as to remove from the flats any impurities that were not taken out by the comb. The brush after it has operated on the flats is cleaned by means of a hackle comb k_1, Figs. 1, 2, and 3, the teeth of which project into the bristles of the brush and remove impurities. The hackle comb is periodically cleaned by hand. The flat strippings are either allowed to fall from the stripping comb on the steel covers m_4, e_8 or are collected on a round rod k_2, Fig. 1, which is suspended directly below the comb and rotated by frictional contact with the flats, thus collecting the strippings as they fall from the flats. These strippings, whether allowed to drop on the steel cover or wound on the surface of the rod, are removed periodically by hand.

19. Cylinder Screen.—Beneath the cylinder is placed a screen e_5, Fig. 3, known as the **cylinder screen.** This consists of circular frames on each side of the card, practically corresponding to the curvature of the cylinder and connected by triangular cross-bars e_6. As shown, the cylinder screen is constructed in halves, which are held together at e_7. It is so supported that it may be set closer to, or farther from, the cylinder, while at the same time it retains practically the same curvature as the cylinder. As the cylinder revolves, the fibers that project come in contact with the screens, and thus the dirt and other foreign substances will be struck off or thrown through the openings in the screens, and cannot be drawn back. The screens also aid in preventing the good cotton from leaving the cylinder. A screen of a similar character was mentioned as being placed below the licker; the licker screens and cylinder screens are usually connected so as to form one complete adjustable undercasing beneath both licker and cylinder.

20. Card Frame.—The entire mechanism thus far described is supported on the framework of the card. This consists of two strong and solid card sides l, which are

connected by cross-girts l_1 with the ends accurately milled and securely bolted to the card sides, thus forming a large rectangular frame. To this is attached a partition l_3, Fig. 3, that separates the dirt and fly produced by the mote knives from the licker and cylinder fly. In the card under description, this partition only projects downwards for half the distance between the licker screen and the floor. In some styles, however, the partition extends down to the floor and has a door in the center so that access can be obtained to the rear of the cylinder screen and space below. Around the framework of the card are doors l_2 that can be removed for the purpose of removing fly, setting undercasings, or examining the under parts of the card. There are four of these doors on each side of the card in addition to one at the front and one at the back.

21. Doffer.—Directly in front of the cylinder, in Figs. 1, 2, and 3, is seen the doffer m, which is supported by the doffer shaft m_1 and is constructed on the same principle as the cylinder. It consists of a perfectly rigid cylindrical shell m_2, carried at each end on a spider m_3 with six arms, to which it is firmly secured, the whole being rigidly attached to the doffer shaft. The doffer is covered with card clothing in a similar manner to the cylinder, except that the wire on the doffer is more closely set and somewhat finer. The doffer is the same width as the cylinder, but is of a much smaller diameter usually about 24 inches, but sometimes 27 inches. A large doffer is to be preferred, since it gives the same production with a lower speed or a larger surface speed with the same number of revolutions, and also gives the cylinder a better chance to deliver the fibers on account of its presenting a larger wire surface, although the advantage is not very great in either case. The doffer revolves in the opposite direction to that of the cylinder, the respective direction of motion at the place where they most nearly approach one another being shown by arrows in Fig. 3. At this place also the teeth of the cylinder and doffer point in opposite directions. As the teeth of the cylinder point in the direction in

which it moves and were pointing upwards at the place where they took the cotton from the licker, they consequently point downwards at the front of the card, while the teeth of the doffer at this place point upwards. The surface speed of the doffer, which varies from 44 to 107 feet per minute, is much less than that of the cylinder. As the cylinder approaches the doffer its surface is covered with separated fibers of cotton. Since it is set within about .005 inch from the doffer and the doffer is revolving so much more slowly, the fibers of cotton are deposited by the cylinder on the face of the doffer. They are condensed considerably from their arrangement on the surface of the cylinder because while spread over from 20 to 40 inches on the surface of the cylinder, they are laid in the space of about 1 inch on the surface of the doffer. The amount of this condensation varies according to the relative speed of the cylinder and doffer.

It does not necessarily follow that all the fibers are taken from the cylinder by the doffer the first time the cotton passes the point where the transfer is made, as they may not be in the proper position to become attached to the doffer. In this case, they may be carried around by the cylinder a second time and be more effectively carded. The doffer may be considered as merely a convenient means of removing the fiber from the cylinder. It is not intended to have any cleaning action, as the cleaning on the card is practically completed when the cotton has passed the flats, but as a matter of fact, it does remove some short fiber and light impurities that adhere within the interstices of the wire.

There is no screen beneath the doffer, as it is unnecessary, but placed above it is a protection consisting of a metal cover m_4 known as the **doffer bonnet** and shown in Figs. 1, 2, and 3, while another view is given in Fig. 18. This metal cover extends over the upper surface of ·the doffer, protects it from injury, and forms a portion of a receptacle to hold flat strippings in case no other method of gathering them is provided. At the point m_5 it extends to, and is almost in contact with, a plate of steel e_8 placed over the front part of the cylinder that performs the same duty

for the cylinder; namely, protecting it from damage and forming a part of the receptacle for the flat strippings. This plate e_8 extends upwards until a loose portion e_9 is reached, which forms a door, the position of which, when closed, is shown in Fig. 18 in dotted lines. This door swings on arms e_{10} so constructed that it can be thrown forwards and rest on the doffer bonnet; it is shown in this position in Fig. 18. Immediately above the space formed by the opening of this door is another plate e_{11}, which extends from the
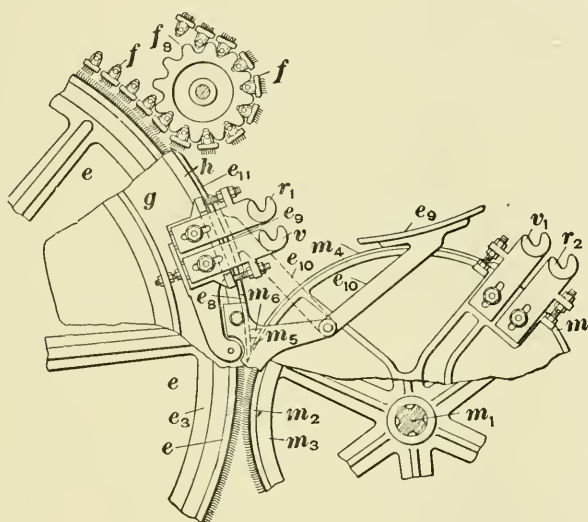
FIG. 18

door up into the space between the flats and the cylinder, almost in contact with both of them. This plate e_{11} is known as the **front knife plate.** It is also the object of these covers, or plates, mentioned in connection with the cylinder, doffer, and licker, to guard against accidents to the operatives, the licker being especially dangerous.

A draft strip, or making-up piece, m_6 is usually placed in the recess formed by the doffer bonnet and the plate e_8, so as to fit the angle between the doffer and the cylinder and thus prevent dirt from entering the space between these two

parts. It also prevents draft and thus does away with fly, which would otherwise gather and come through in lumps.

22. Doffer Comb.—The cotton is carried around by the doffer on its under side until it reaches the doffer comb n, Fig. 3, which is directly in front of the doffer and has an oscillating motion of about 1,800 or 2,000 strokes per minute. One of the bearings of the comb is an ordinary bearing,
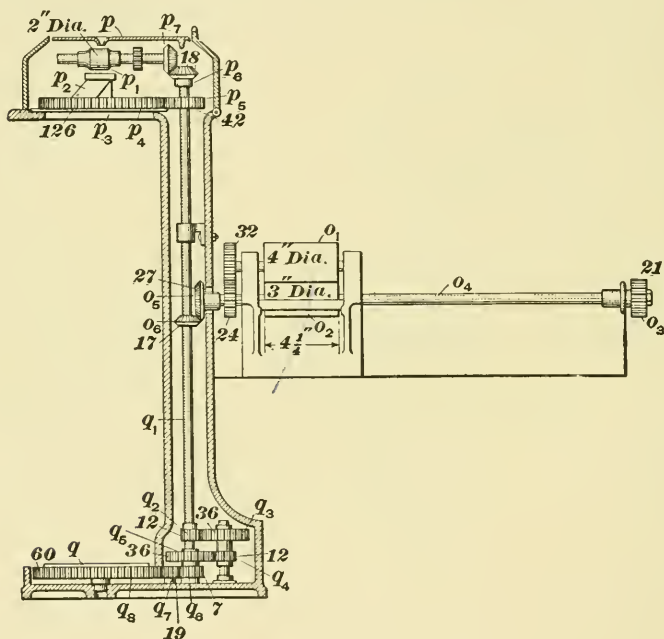
Fig. 19

while the other is in a box known as the **comb box,** which contains the eccentric that gives the motion to the comb. The position of these bearings can be altered by adjusting screws in order to obtain the proper distance between the comb and the surface of the doffer. The comb, as shown in Figs. 1, 2, and 3, consists of a thin sheet of steel attached to a shaft by a number of small arms; its lower edge is composed of fine teeth resembling somewhat the teeth of a fine

saw. The teeth of the doffer, which were pointing upwards when in position to receive the cotton from the cylinder, are pointing downwards at the point nearest the comb. The downward strokes of the comb are in the same direction that the teeth of the doffer are pointing and in close proximity to them, thus making the operation of removing the cotton very easy.

The cotton, when it leaves the doffer, is in the form of a transparent web of the same width as the doffer. The next work required of the card is that of reducing the web to a sliver. This is attained by passing the cotton through a guide and then through a trumpet o, on the other side of which are two calender rolls o_1, o_2, Figs. 1, 3, and 19. The bottom roll is $4\frac{1}{4}$ inches wide and 3 inches in diameter, and by means of a gear drives the top calender roll, which is self-weighted, being 4 inches in diameter. The object of these rolls is to compress the sliver so that it will occupy a comparatively small space.

23. Coiler.—From the calender rolls o_1, o_2 the cotton passes through a hole in the cover p of the upright framework, known as the **coiler head**, the connections of which are shown in Fig. 19. It is drawn through the hole in the cover by two coiler calender rolls, the one shown being marked p_1, which further condense it, and is then delivered into an inclined tube p_2 on a revolving plate p_3. The end of the tube that receives the cotton is in the center of the plate, directly under the calender rolls p_1, while the end of the tube from which the cotton is delivered is at the outer edge of the plate p_3. At the bottom of the coiler head is a plate q on which rests the can that receives the sliver. In consequence of the sliver being delivered down the rotating tube p_2, it will describe a circle and be laid in the can in the form of coils. The circle described by the bottom of the tube p_2 is little more than half the diameter of the can. If the top of the tube p_2 were directly over the center of the plate q on which the can rests and if the can did not turn, causing the laying of the sliver to depend entirely on the rotation of the coiler

tube, the sliver would be placed in a series of ascending coils, which would have as a center the center of the can, while the outside edges of the coils would be placed some distance from the side of the can. The result of this would be that only a very short length of sliver could be laid in the can and the coils would become entangled, causing the sliver to be broken as it was drawn out. In order to overcome this difficulty the top of the tube p_2 is slightly beyond the center of the plate q, while q is revolving in the opposite direction to that of the tube p_2, but very slowly as compared with the speed of this tube, p_2 making about 26 revolutions to 1 of q.
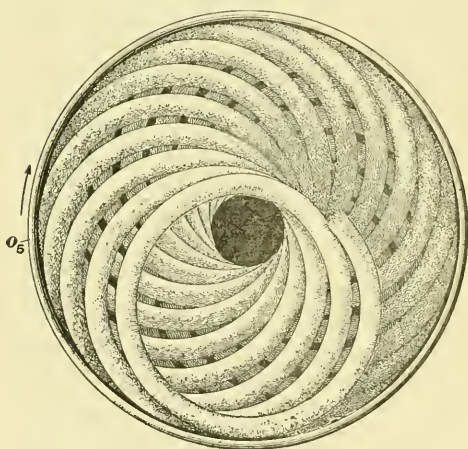
Fig. 20

As a result of this arrangement each coil of sliver that is placed in the can is in contact with the side of the can and no one coil comes directly above the preceding coil. A top view of the sliver as it appears when placed in the can in this manner is shown in Fig. 20.

The cover for the coiler head is now constructed so as to be held in position by a hinge, on which it can be raised and held open, without breaking the sliver. This gives an opportunity for inspection and oiling.

Formerly coiler heads were so constructed that it was necessary to remove the sliver from the coiler or break the end of sliver in order to oil the bearings, which necessarily caused additional waste and loss of production. Occasionally the sliver breaks and collects within the coiler, causing what is called a *bung-up*.

One feature of the coiler head for the card under description is the use of the swinging calender roll in place of the

old-style calender roll, which revolved in fixed bearings and caused considerable trouble in case of a bung-up in the coiler head. The calender roll that receives motion from the upright shaft revolves in fixed bearings, while the other one is mounted on a swing, or hinge, bearing. The weight of the roll and bearing is sufficient to keep it in contact with the fixed roll. It receives motion from the other roll by means of two spur gears, one on the shaft of the roll revolving in fixed bearings and the other on the shaft of the swinging roll. When the coiler tube chokes, the sliver collects around the top of it and forces the swinging roll up, thus throwing it out of gear with the fixed roll and preventing any more cotton from entering the coiler. When a lap forms on either roll, the increasing diameter of the roll forces up the swinging roll and thus prevents the cotton from winding so firmly around the roll. This arrangement is also very convenient because of the fact that the swinging roll can be moved out of the way in removing the cotton that has lapped around one of the rolls, thus making it very easy to remove the lap, whether it has formed on the swinging roll or on the stationary roll. It also does away with the strain on the bearings and the necessity of using a knife to cut the lap from the roll, and thus prevents the surface of the roll from being damaged by the careless use of a knife.

<div align="center">GEARING</div>

24. In describing the method of driving the different parts of the card reference will be made to Figs. 21 and 22, but in order to more fully identify the parts, the plan of the gearing, Fig. 23, and also those figures that show the parts of the card assembled, such as Figs. 1 and 2, should be consulted, especially for those parts that cannot well be indicated on Figs. 21 and 22. Referring first to Fig. 21, which shows the main driving side of the card, the tight pulley e_{12} on the end of the cylinder shaft receives motion from the driving belt e_{14}, which is driven from the pulley either on the main shaft or a countershaft of the room. On the other side of the cylinder, as shown in Fig. 22, is placed a pulley with four

separate faces, the face e_{15} carrying the crossed belt that
drives the pulley c_5 on the licker c.   Referring again to Fig. 21,
on the other end of the licker is a pulley c_6 that drives the
barrow pulley m_7 by means of a crossed belt.   Compounded
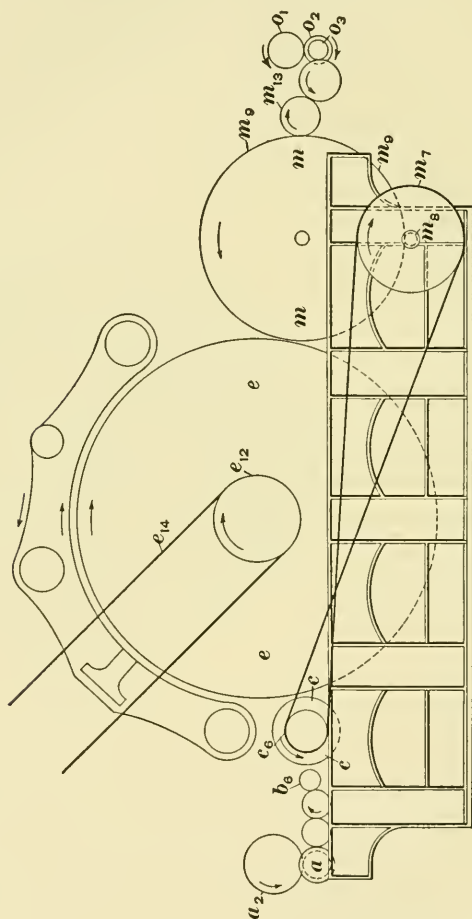
FIG. 21

with this pulley is the barrow gear m_8, which drives the doffer
gear m_9 on the end of the doffer shaft.

Reference should now be made to Fig. 22, which shows
the other side of the doffer.   On this side is a bevel gear m_{10}

driving a bevel gear m_{11} on the side shaft m_{12}, which carries
at its other end a bevel gear b_4 driving a gear b_6 on the end
of the feed-roll.   On the other end of the feed-roll, as shown
in Fig. 21, is a gear b_6 that drives by means of two carrier
gears the lap roll a.   Referring again to Fig. 22, the pulley e_{16},
by means of the band n_5, drives the pulley n_4 that is com-
pounded with another pulley n_2; this, by means of the band n_3,
drives a pulley n_1 on a short shaft carrying the eccentric that
gives motion to the doffer comb.   A third pulley e_{17}, on the
end of the cylinder shaft, as shown in Fig. 22, drives by
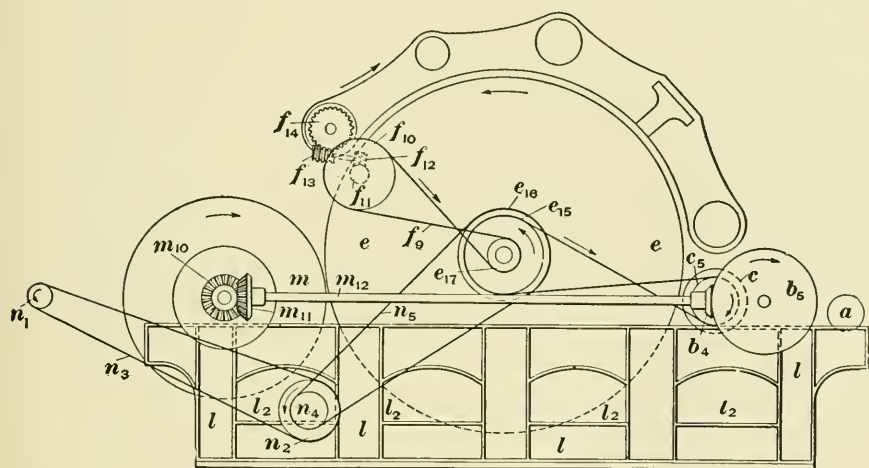
FIG. 22

means of the belt f_9 the pulley f_{10}, which is on the same shaft
as the worm f_{11} gearing into the worm-gear f_{12}.   On the short
shaft with the worm-gear f_{12} is a worm f_{13} driving the worm-
gear f_{14}, which is mounted on a shaft carrying two sprockets
that gear directly into the ribs on the back of the flats.

The coiler connections are driven as follows, reference
being made to Figs. 19 and 23:   The large gear m_9, Fig. 23.
that is on the end of the doffer and receives motion from
the barrow gear, drives by means of two carrier gears a
gear o_3 on one end of the calender-roll shaft o_4.   On the
other end of this shaft is a bevel gear o_5, Fig. 19, that drives
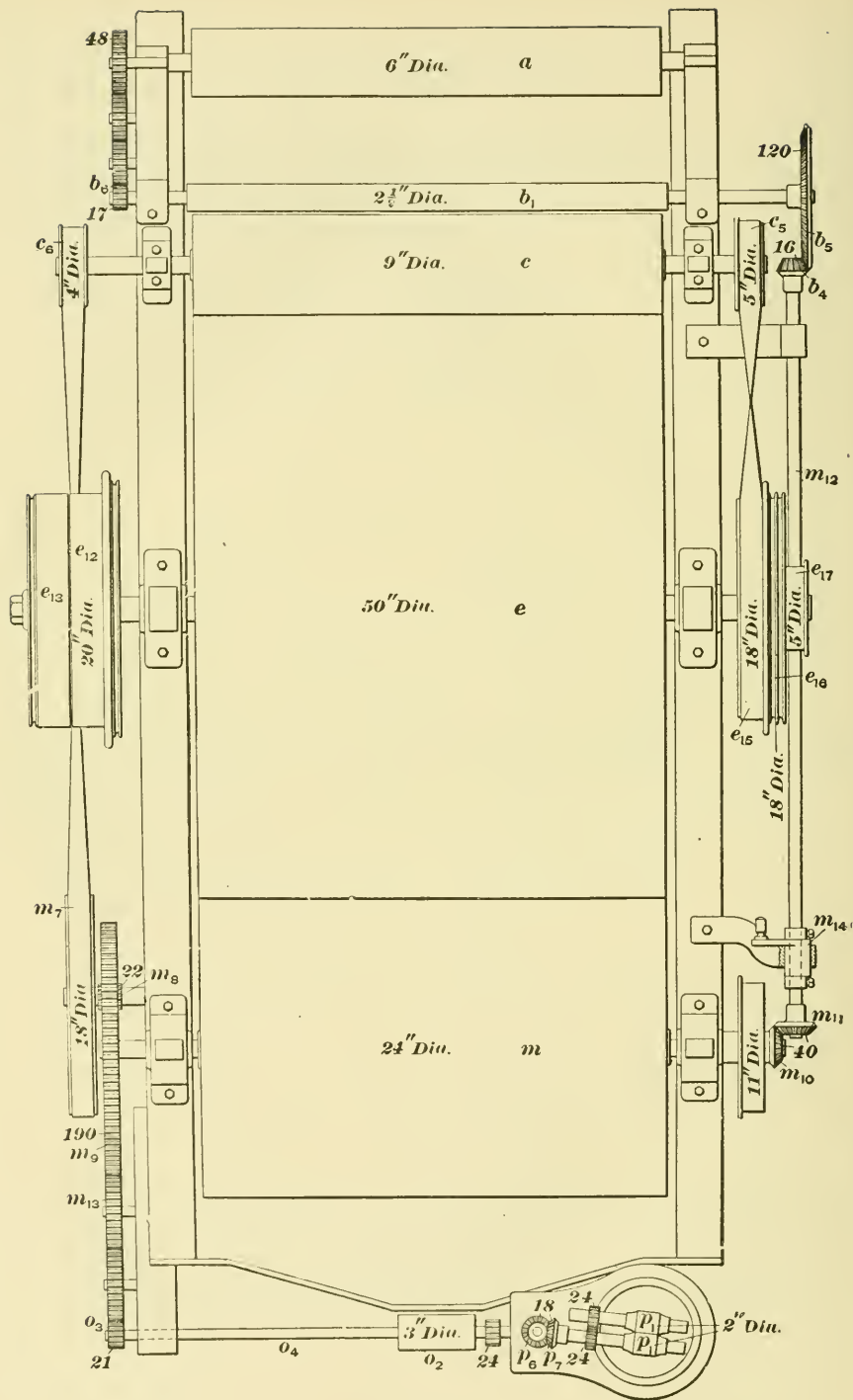
Fig. 23

the bevel gear o_5 on an upright shaft. At the upper end of this upright shaft are two gears, the gear p_5 driving the gear p_4 on the coiler plate, while the bevel gear p_6 drives the bevel gear p_7 on the coiler calender-roll shaft. The can table q is driven by means of a number of gears at the bottom of the upright shaft and in a rather circuitous manner, which is rendered necessary in order to obtain the slow motion at which the can table should travel. The gear q_2 is fast to the upright shaft q_1, while the gears q_5, q_6 are loose on the same shaft but compounded by means of a sleeve. The gear q_2 drives the gear q_3, which is compounded with the gear q_4, both gears working loosely on a short upright stud. The gear q_4 drives the gear q_5, and since q_5 and q_8 are compounded, the gear q_8 on the can table will receive motion through the carrier q_7.

25. When it is desired to stop the card from delivering the cotton and yet not break down the end at the coiler, the catch l_4, Fig. 24, is released. This figure shows one method of driving a doffer; it will be seen that as the feed-roll, calender roll, and all coiler connections are driven from the doffer, they will stop when the catch l_4 is released, throwing the gear m_8 out of contact with the doffer gear m_9. By this method it is a simple matter to stop the delivery of the cotton very suddenly if necessary and at the same time allow the swiftly revolving parts, such as the cylinder and licker, to remain in motion. Another advantage of this arrangement is that no waste results when the delivery is stopped. When the gear m_8 is again meshed with the gear m_9, the portion of the doffer that was presented to the cylinder when the doffer was stopped will contain an excessive amount of cotton. This excess will cause a thick or uneven place in the sliver, which should be removed. This arrangement is sometimes called the *barrow motion*, and the gear m_8 the *barrow gear*.

The gear m_8 is usually a change gear, so that the doffer may be driven at any required speed, as the production of the card depends on the speed of the doffer. In decreasing or increasing the speed of the doffer by changing the
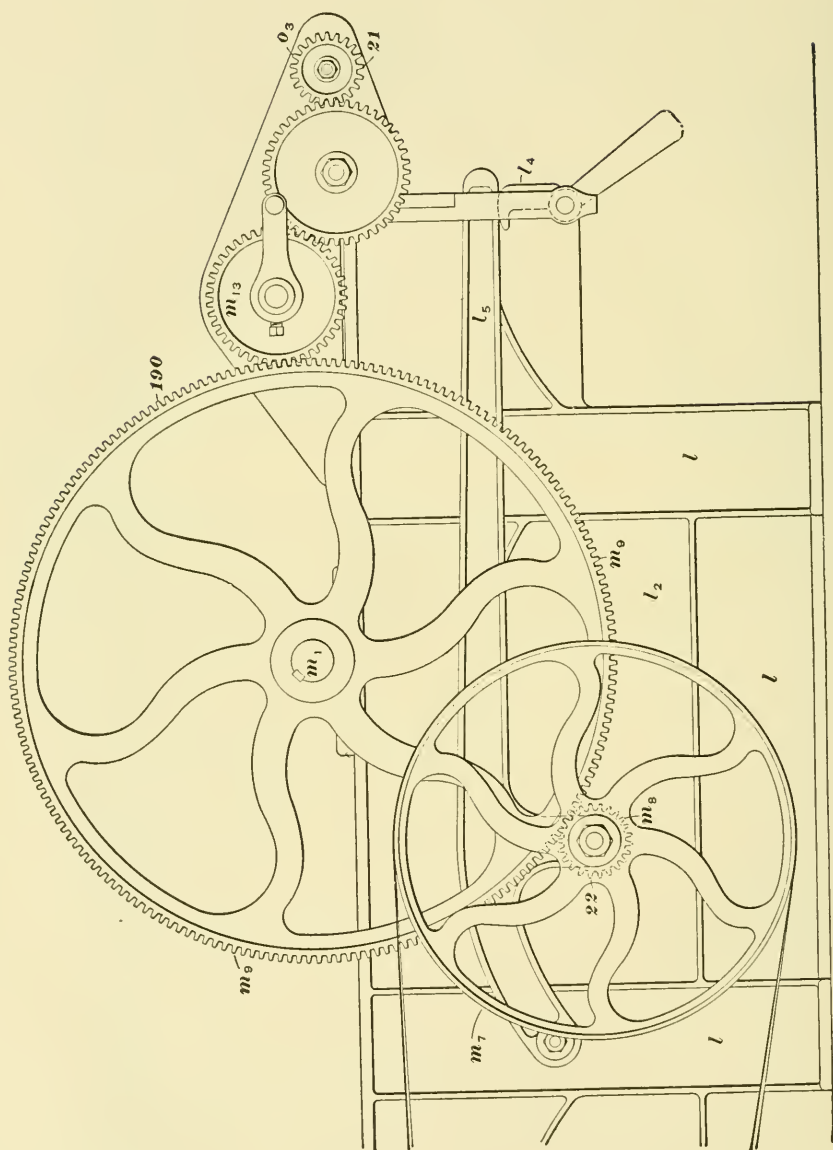
Fig. 21

gear m_8, the draft of the card and, consequently, the weight of the sliver delivered, are not affected, since the feed-rolls, lap roll, and all coiler connections receive motion from the doffer and therefore have the same relative speed, whether m_8 is a large or a small gear.

Another method of stopping the delivery of the cotton without breaking down the end at the coiler is to break the connection at the doffer by moving the side shaft m_{12}, Figs. 22 and 23, and also break the connection between the doffer and calender rolls by turning the handle on the carrier gear m_{13}, Fig. 24.   The shaft m_{12} carries a gear at each end, the gear b_4 driving the gear b_5 that is on the end of the feed-roll, while the gear m_{11} receives motion from the gear m_{10} on the end of the doffer shaft.   By means of the movable bearing m_{14}, it is possible to move the shaft m_{12} outwards at its front end and thereby disconnect the gears m_{10}, m_{11} and thus stop the feed, while by throwing out the gear m_{13} the calender rolls are stopped, thus allowing the cotton that is on the doffer to fall between the doffer and the calender rolls. This method of stopping the delivery of cotton by the card allows the doffer to run without making an uneven and cut sliver when restarting.

<div style="text-align:center">———</div>

SPEED CALCULATIONS

26.   If the driving shaft makes 340 revolutions per minute and carries a 10-inch pulley, the pulley e_{12}, Figs. 21 and 23, which is 20 inches in diameter, will be driven as follows:

$$\frac{340 \times 10}{20} = 170 \text{ revolutions per minute}$$

As the cylinder is $50\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will therefore be as follows:

$$\frac{170 \times 50\frac{3}{4} \times 3.1416}{12} = 2{,}258.679 \text{ feet per minute}$$

27.   **Licker.**—On the end of the cylinder opposite that of the pulley e_{12} is the pulley e_{15}, Figs. 22 and 23, which is connected to the pulley c_6 by means of a cross-belt and thus

drives the licker. The diameter of e_{15} is 18 inches and that of c_8 is 7 inches, so that when the cylinder makes 170 revolutions per minute, the revolutions per minute made by the licker will be as follows:

$$\frac{170 \times 18}{7} = 437.142 \text{ revolutions per minute}$$

As the licker is usually 9 inches in diameter, its surface speed will be as follows:

$$\frac{437.142 \times 9 \times 3.1416}{12} = 1,029.993 \text{ feet per minute}$$

28. Doffer.—The 4-inch pulley c_6, Figs. 21 and 23, on the end of the licker drives the 18-inch barrow pulley m_7, which is compounded with the doffer change gear m_8. This gear, for the purpose of calculation, will be assumed to have 22 teeth; the gear on the end of the doffer contains 190 teeth. With the licker making 437.142 revolutions per minute, the speed of the doffer will be as follows:

$$\frac{437.142 \times 4 \times 22}{18 \times 190} = 11.248 \text{ revolutions per minute}$$

As the doffer is $24\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will be as follows:

$$\frac{11.248 \times 24\frac{3}{4} \times 3.1416}{12} = 72.881 \text{ feet per minute}$$

On some cards there is an arrangement for driving the doffer at two different speeds, the slow speed being used when piecing up an end. One method of construction for driving at different speeds is to have two pulleys of different sizes on the licker shaft and to have two belts extending to m_7. At m_7 there are three pulleys, the center pulley being loose, while the other two are fastened to the shaft; consequently, when one belt is on the loose pulley, the other is on one of the fastened pulleys. The belts are shifted by means of a shipper handle.

29. Flats.—With the cylinder making 170 revolutions per minute; diameter of e_{17}, Figs. 22 and 23, 5 inches; diameter of f_{10}, 10 inches; f_{11}, single-threaded worm; f_{12},

16 teeth; f_{12}, single-threaded worm; f_{14}, 42 teeth; and diameter of pulley driving flats, 8 inches; the speed of the flats will be as follows:

$$\frac{170 \times 5 \times 1 \times 1 \times 8 \times 3.1416}{10 \times 16 \times 42} = 3.179 \text{ inches per minute}$$

30.   Draft.—The following examples illustrate the manner of finding the draft:

EXAMPLE 1.—Find the draft between the lap roll and feed-roll, referring to Fig. 23 for data.

SOLUTION.— $\dfrac{2.5 \times 48}{6 \times 17} = 1.176$, draft.   Ans.

EXAMPLE 2.—Find the draft between the feed-roll and doffer, using a 16 change gear at b_4.

SOLUTION.— $\dfrac{24 \times 40 \times 120}{2.5 \times 40 \times 16} = 72$, draft.   Ans.

EXAMPLE 3.—Find the draft between the doffer and bottom calender roll.

SOLUTION.— $\dfrac{3 \times 190}{24 \times 21} = 1.13$, draft.   Ans.

EXAMPLE 4.—Find the draft between the bottom calender roll and coiler calender rolls, referring to Fig. 19 for data.

SOLUTION.— $\dfrac{2 \times 24 \times 18 \times 27}{3 \times 24 \times 18 \times 17} = 1.059$, draft.   Ans.

EXAMPLE 5.—Find the total draft of the card shown in Fig. 23, figuring from the coiler calender rolls p_1, Figs. 19 and 23, to the lap roll a, Figs. 21 and 23, and using a 16 change gear at b_4.

SOLUTION.— $\dfrac{2 \times 24 \times 18 \times 27 \times 190 \times 40 \times 120 \times 48}{6 \times 24 \times 18 \times 17 \times 21 \times 40 \times 16 \times 17} = 101.433$, draft. Ans.

PROOF.—To prove that intermediate drafts equal total draft, $1.176 \times 72 \times 1.130 \times 1.059 = 101.324$.

31.   Waste.—In the passage of the cotton through the card there are several places where waste is made.   There is a certain amount under the licker and the cylinder, and also between the wires of the clothing on the flats, cylinder, and doffer.   This amount of waste should not as a rule exceed 5 per cent., and the work of the card should be closely watched, especially with regard to the waste under the

cylinder, which should be examined at frequent intervals to see if it contains too much good cotton.

32. Production.—The production of the card varies according to the class of work, a good production on low numbers being from 700 to 1,000 pounds per week, while for fine yarns it is much lower. The weights of delivered sliver suitable for certain classes of work are as follows:

Variety of Cotton	Numbers	Weight per Yard Grains
Average American . . .	1s to 10s	70
	10s to 15s	65
	15s to 20s	60
	20s to 30s	55
	30s to 40s	50
Allan-seed and Peelers .	40s to 60s	50
	60s to 70s	45
	70s to 100s	40
Egyptian	40s to 60s	55
	60s to 70s	50
	70s to 100s	45
Sea-Island	70s to 100s	35
	100s upwards	30

33. Weight and Horsepower.—The weight of a single revolving flat card is about 5,000 pounds. It requires from $\frac{3}{4}$ to 1 horsepower to drive it after the initial strain of starting, which requires much greater power.

34. Dimensions.—A 40-inch revolving flat card with a 24-inch doffer occupies a space about 9 feet 11$\frac{1}{2}$ inches by 5 feet 4 inches. Extra allowance must be made for the diameter of the lap. When the doffer is 45 inches wide, 5 inches must be added to the width in the above dimensions, while 3 inches must be added to the length when the doffer is 27 inches in diameter.

COTTON CARDS

(PART 2)

FORMER METHODS OF CARD CONSTRUCTION

1. While the machine described in *Cotton Cards*, Part **1**, is the one that is now almost universally adopted for cotton carding, it does not by any means adequately represent the different methods of carding that are, or have been, used. The method of carding cotton before the era of machinery was by means of hand cards, which consisted merely of pieces of wood about 12 inches long and 5 inches wide to which a handle was attached. A piece of leather through which a number of iron wires had been driven was attached to the surface of the board and two of these hand cards were used, the operator holding one in each hand. The cotton, after being picked and cleaned, was spread on one of these cards, and the other was used to brush, scrape, or comb it until the fibers of cotton lay comparatively parallel to one another. From this were obtained soft fleecy rolls about 12 inches long and $\frac{3}{4}$ inch in diameter, called *cardings*. These cardings were pieced together and spun on the hand spinning wheel. Later developments resulted in the introduction of the principle of carding by means of a cylinder carrying wire teeth operating against a stationary framework carrying wire teeth, this being the first style of mechanical card. From this was ultimately developed a card used very largely in America under the name of *stationary-top flat card*, and to a limited extent in Europe, under the name of the *Wellman card*. This stationary-top flat card was used in almost every

American cotton mill until within the last 10 years, and is still used occasionally.

The most popular style of card in Europe prior to the development of the revolving-top flat card was that known as the *roller-and-clearer card*, sometimes called the *worker-and-stripper card*. This roller-and-clearer card was constructed with either one or two cylinders, being known respectively as a single or a double card. Sometimes a combination card was built with rollers and clearers on the back cylinder and flats on the front; combination cards have also been built with single cylinders having flats at the front and rollers and clearers behind. For special purposes cards have been built with three cylinders. The system of carding cotton by rollers and clearers, or workers and strippers, somewhat resembles the methods now in use for carding purposes in the woolen industry.

Owing to the world-wide tendency now to adopt the revolving-top flat card in the cotton industry, considerable space has been devoted to thoroughly describing that style of construction, but as there are still in use a number of stationary-top flat cards and also a number of the roller-and-clearer cards, a brief description of each of these styles of construction will be given.

STATIONARY-TOP FLAT CARD

2.   The **stationary-top flat card**, shown in Fig. 1, is a smaller and less substantial machine than the revolving-top flat card, but is very similar to it in the principle of carding the cotton, differing mainly in the method of stripping the flats. The machine consists of the usual framework supporting the cylinder and doffer together with the various parts common to all cards, while above the cylinder are placed a number of flats. In the older cards these are constructed of wood, as shown in Fig. 1, but in the newer cards they are made of iron. Iron flats are usually made $1\frac{3}{8}$ inches wide with a strip of clothing $\frac{13}{16}$ inch wide, and it is possible to have 40 of them extending over an arc equal to about two-fifths of the circumference of the cylinder. When wooden flats

are used it is not possible to have so many.   The functions
of these flats are the same as of those in the revolving flat
card previously described.   The flats rest on the arch of the
card and are so constructed as to preserve the proper angle
with the card wire on the cylinder.   Each flat is set inde-
pendently of any other by means of threaded pins secured
by nuts.

The peculiarity of this card consists in the method of
stripping the flats.   An arrangement is shown above the
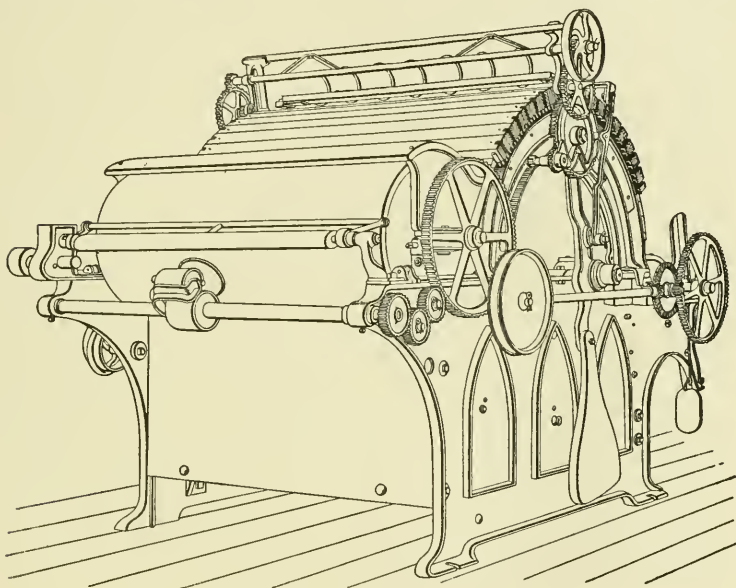
Fig. 1

machine in Fig. 1 by which any one flat may be raised from
its seat sufficiently to allow a stripping card to be passed
beneath it and drawn across its face, removing the impurities,
which are retained in a wire framework; immediately after
the stripping is completed the mechanism lowers the flat to
its position.   As this one piece of stripping mechanism has
to clean each flat, it is necessary to have it so constructed
that it may be moved from one flat to another; this is

provided for, as shown in Fig. 1, by means of a small gear, which is a part of the stripping mechanism, meshing with a semicircular rack arranged on the arch of one side of the card; as this gear revolves the mechanism is moved from flat to flat. This can be arranged either to strip the flats consecutively, thus the first, second, third, fourth, and so on, or to strip them alternately, thus stripping the first, third, fifth, seventh and returning to strip the second, fourth, sixth, eighth, etc.; or in the improved quick stripper it may be made variable in its action, in order to strip the flats nearest to the feed-rolls oftener than those nearest to the doffer. This stripper lifts, strips, and replaces a flat in less than 4 seconds. The stationary-top flat cards are usually made with all parts smaller than either the revolving-top flat cards or the roller-and-clearer cards. The main cylinder is not usually more than 42 inches in diameter and the doffer not more than 18 inches, while the width of the card is not generally more than 37 inches. The construction of the stationary-top flat card made it especially suitable to be used in sections of a number of cards that delivered the slivers to a traveling lattice. The latter conveyed them to a *railway head*, a machine that combines all the slivers into one sliver which it deposits into a can in suitable form for the next process. This method was, and is still to some extent, used where double carding is resorted to; however, owing to the comparatively small amount of the production for the floor space occupied and the difficulty of arriving at accurate settings and adjustment, especially where wooden flats are used, it is now largely replaced by the revolving-top flat card.

A modern construction of a stationary-top flat card occupies 9 feet 6 inches by 5 feet 6 inches with a coiler, and 8 feet 2 inches by 5 feet 2 inches without a coiler. When making a 60-grain sliver with the doffer making 10 revolutions it cards about 60 pounds per day; it of course produces more than this on coarse work with a heavier sliver and the doffer running more quickly, and less for fine work with a slower doffer speed and lighter sliver.

ROLLER-AND-CLEARER CARD

3. The **roller-and-clearer card**, a section of which is shown in Fig. 2, although rarely used in America, is employed to some extent in certain parts of Europe. The machine consists primarily of a cylinder d, 45 inches in diameter, which is covered with fillet card clothing and rotates at a surface velocity of about 1,600 feet per minute. Placed over this cylinder are a number of **rollers** e about 6 inches in diameter, sometimes known as **workers**, and also a number of **clearers** f about $3\frac{1}{2}$ inches in diameter, sometimes called **strippers**. Both the workers and clearers are covered with fillet card clothing, the former rotating at a surface velocity of about 20 feet per minute and the latter at a circumferential speed of about 400 feet per minute. The clearers are set in close proximity to the cylinder, and the workers are adjusted both to the cylinder and to the clearers. These settings are obtained by means of screws and setting nuts with which the poppet heads g that support the shafts of the workers and clearers can be adjusted. The clearers are driven from a pulley d_1 on the cylinder shaft by means of a belt, or band, d_2 passing over pulleys on the clearer shafts and also around a binder pulley h. The workers are usually driven by a pulley on the doffer shaft that drives a belt, band, or in some cases a chain passing around pulleys or sprockets on the shafts of all the workers. The card is equipped with an 8-inch licker c, which is covered with fillet and rotates at a surface velocity of about 700 feet per minute; a doffer j of the ordinary construction is also employed.

In operation, a lap a_1 is placed in stands at the back of the card and, resting on a rotating wooden roll a, is fed to the card by means of a fluted feed-roll b_1 and a feed-plate b. As the licker c rotates downwards past the feed-plate, its teeth take the cotton that is fed to it and carry it to the cylinder d. The points of the teeth on the cylinder moving rapidly past the backs of the teeth on the licker results in the former taking the cotton from the latter and conveying it to the doffer. In its passage from the licker to the doffer,
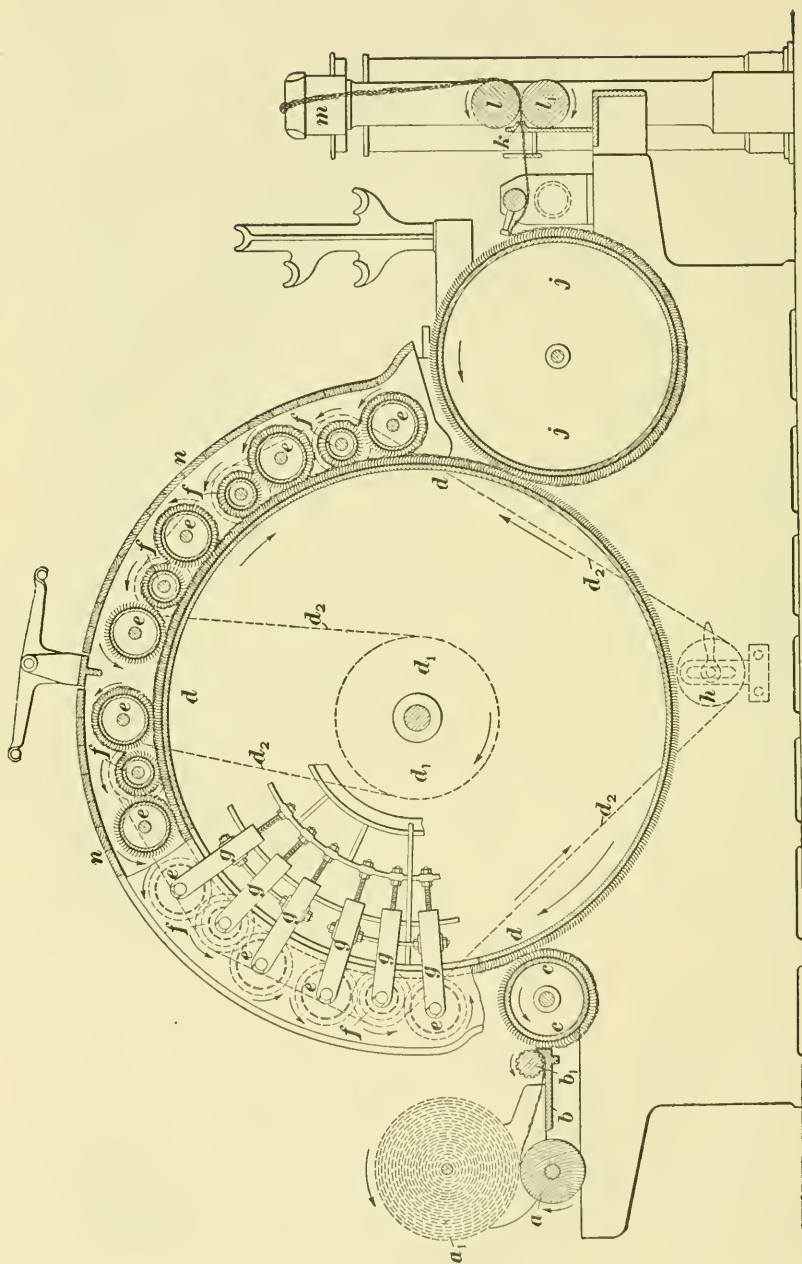
FIG. 2

however, the cotton is subjected to the action of each of the workers. The stock is held loosely and projects somewhat from the teeth of the cylinder, which rapidly pass the workers and operate point against point with the teeth of the latter. The result of this is that the cotton is carded and opened out and deposited on the workers, where it remains until the rotation of the worker brings it under the action of the clearer. Since the teeth of the clearer work with their points against the backs of the teeth on the worker, they take the cotton from the latter and convey it back to the main cylinder, which by virtue of its speed and the direction of inclination of its teeth, strips the cotton from the clearer. The expressions point against point and point against back, when referring to the card teeth of the various rolls, should not be construed to mean that the teeth of any two rolls are in actual contact, as these expressions refer only to the relative inclination of the card teeth. It will be noticed that the first eight workers are arranged in pairs, each pair being stripped by a single clearer, but that the last two workers are each stripped by a separate clearer. Sometimes the entire complement of workers and clearers are arranged as are the last two in the illustration. The cotton is taken from the cylinder by the doffer j in the ordinary manner and passed to the coiler m through the trumpet k and calender rolls l, l,. This form of card is apt to make a considerable amount of flyings on account of the speed of the various parts, and in order to prevent these from flying from the card the latter is enclosed with a wooden cover n.

This method of carding results in the stock being thoroughly opened and cleaned, and it is claimed that it does less damage to the fibers and that a yarn 5 per cent. stronger can be produced than by the methods in more common use at the present time. As this card, however, requires more help to operate it and does not produce as much work as the more recent card, its use is not considered profitable.

DOUBLE CARDING

4. Formerly in order to obtain a high-grade yarn it was considered necessary to adopt the principle of **double carding**; viz., that of carding cotton first on a breaker card and then, after having taken a number of the slivers and by means of a lap head formed them into a lap, putting this lap through a finisher card. Since the revolving flat card has been improved so greatly that it does almost as good work as was done with the old system of double carding, and since the introduction of the comber, which produces work superior to either double carding or revolving flat card products, double carding is going out of practice.

5. Formation of the Lap.—The cards employed in double carding are similar to those already described and need no further mention. The formation of the lap for the second process of carding may be accomplished in several ways: (1) Where the breaker cards deposit slivers in cans, the lap is usually formed by means of a Derby doubler. (2) Where the first carding is arranged in sections of six, eight, ten, or twelve cards connected by a railway trough, the slivers may be passed through a railway head, in which they are deposited in a can, and afterwards passed through a lap head. (3) The slivers from the section of a railway trough may be guided directly into a lap head and the lap formed in this manner.

The first method, that of using a Derby doubler, is an arrangement by which a number of cans from the breaker cards, varying from twenty to sixty, are placed behind a long **V**-shaped table and the slivers from them passed through rolls, forming at the front one wide sheet, which may be any width from 10 to 40 inches. The lap is wound on a roll in somewhat the same manner as a lap is formed in the picker room. This lap is then placed on the lap roll at the finisher card and recarded.

When it is desired to form a lap for the finisher cards without the intervention of the railway head or can system

for each card, the slivers from the railway trough are guided around rolls at such an angle as to arrange for slivers from two or more lines of breaker cards to be guided into a lap head and there wound into a lap usually half the width necessary to supply the finisher card.

CARD CLOTHING

CONSTRUCTION

FOUNDATION

6.   Card clothing is the material with which the cylinder, doffer, and flats of the card are covered and by means of which the cotton is opened and the fibers straightened and laid parallel to each other. It consists of wire teeth bent in the form of a staple and inserted in a suitable foundation material. The teeth in addition to being bent in the form of a staple, also have a forward bend, or inclination, from a point known as the **knee** of the tooth. Fig. 3 is an enlarged view showing the shape of a single card tooth
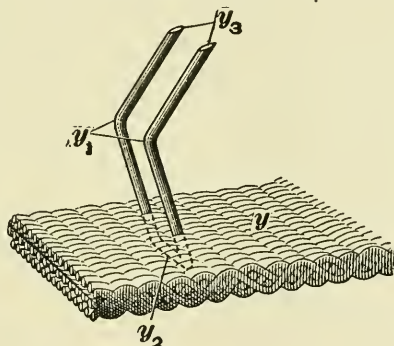
FIG. 3

and the method of inserting it in the foundation y. The knee of the tooth is shown at y_1, while y_2 indicates the portion of the tooth, known as the **crown,** that is on the back of the foundation after the tooth has been inserted in it; y_3 are the **points** of the tooth, each tooth of course having two points.

7.   Although the teeth of the clothing do the actual carding, much depends on the character of the foundation, since if the former are not held with considerable firmness and yet allowed a certain freedom of motion, the best results in carding

cannot be obtained. The foundation material must also be such that it will not stretch after it is applied to the card, for if the clothing becomes loose it will rise in places, or as is commonly said, will *blister*. When this happens not only is the thoroughness of the carding deteriorated, but there is also great liability of the clothing itself being damaged by coming in contact with the clothing on other parts of the card. In addition, if the clothing is slack, the teeth will not be held up to their work properly but will be forced backwards by the strain in carding the cotton; this will result in neutralizing to a certain extent the effect of the forward bend of the tooth, making the clothing act more like a brush and allowing the cotton to pass without being properly carded.

The foundation material generally used is a fabric woven from cotton and woolen yarns, although sometimes cotton and linen are employed, the linen being used on account of its strength and freedom from stretching. The woolen yarn, however, is well adapted for this purpose, as it possesses a certain elasticity that, while holding the tooth in place with sufficient security, allows a certain freedom of movement; this is very desirable, since if the card teeth are held too rigidly, there is some liability of their becoming bent or broken. The foundation is generally woven three- or four-ply, in order to obtain the required strength and the thickness that is necessary to secure the teeth. A very good foundation consists of a two-ply woolen fabric inserted between two cotton fabrics, the latter imparting the requisite strength and the former giving a firm but elastic grip on the teeth. Sometimes the surface of the foundation is coated with a veneer of india-rubber, but in this there are disadvantages as well as advantages. The rubber has a yielding grip on the tooth that allows it enough freedom to move when the strain of carding is on it, and at the same time it is of a tough nature so that the movement of the tooth does not work a large hole in the foundation, which would render the teeth loosely secured so that the full benefit of the elasticity of the wire could not be obtained. The india-rubber-covered clothing is also much easier to strip, but on

the other hand is not so durable as clothing made with the ordinary foundation. The rubber deteriorates with age, becoming hard and stiff and cracking between the points where the teeth pass through it. This deterioration is much more rapid if the clothing is in a hot room or subjected to the direct rays of the sun, and many times it has been found that the foundation of rubber clothing was totally spoiled before the wire was appreciably worn.

TEETH

8. The wire teeth actually do the carding, separating the cotton, fiber from fiber, and rearranging it in a homogeneous mass in which the fibers lie more or less parallel; they are therefore of even more importance than the foundation in which they are inserted. The material from which the wire is made, the number (diameter) of the wire, the angle at which the wire passes through the foundation, the angle at the knee of the tooth, the relative height of the knee and point, and the method of insertion in the foundation are all important considerations when card clothing is to be purchased for general or special uses.

Clothing is set with many different kinds of wire, such as iron, brass, mild steel, tempered steel, tinned steel, etc., but for cotton carding hardened and tempered steel, which makes a springy, elastic tooth that will not easily be bent out of place or broken, is the best material. Mild-steel wire wears too easily, losing its point and requiring frequent grinding to keep the card in good working condition. On the other hand it is easily ground, while tempered steel, although necessitating less frequent grinding, is harder to grind and requires a longer time to secure the required point, since if the grinding operation is forced the wire is liable to become heated and the temper drawn. The strength, elasticity, and durability of the tempered steel, however, make it much more desirable than any other material.

The wire generally employed is round in section, but various other shapes have been used at different times; one

of these was the elliptical form obtained by slightly flatten-ing the round wire by passing it through heavy rolls. While this form gave great strength to the tooth, it was objection-able because the teeth had a tendency to work holes in the foundation. After round wire has been set in the foundation it is ground to a point, and this alters the form of the section of the tooth at the point, or in some cases as far down as the knee, although the part of the tooth that passes through the foundation is always round in section. There are three methods of grinding the clothing, which give to it the following names: (1) *top-ground;* (2) *needle-*, or *side-*, *ground;* (3) *plow-ground.*

9. Top-ground wire is obtained by an emery grinding roll having a very slight traverse motion, so that the point of the tooth is ground down only on the top, producing what is known as a **flat,** or **chisel,** point.

In the **needle-,** or **side-, ground wire** the thickness of the tooth is reduced at the sides for a short distance from the point, and the wire is also ground down at the top. This form of point is known as the **needle point** and is produced by a comparatively narrow emery grinding wheel that, in addition to having a rotary motion, is rapidly traversed back and forth across the clothing.

Both top and needle grinding are practiced in the mill, the former being accomplished with the so-called dead-roll and the latter with the traverse grinding roll, but **plow grinding** is usually done by the manufacturers of the clothing. With this method of grinding, the thickness of the wire is reduced by grinding down each side from the point of the tooth to the knee. This is accomplished by means of emery disks that project into the clothing to the knee of the tooth. To aid in this method of grinding, the teeth are separated by means of plows, or guides, so that the emery disk will pass between the wires and not knock down the teeth, hence the name plow-ground. A plow-ground tooth is the best, since it is not only strong, elastic, and easily kept in good condition, but also gives a wedge-shaped space

between the teeth, which can more readily engage with the cotton, and at the same time does not reduce the number of points per square foot. It should be understood that plow grinding alone does not give the necessary keen point to the tooth, as it simply reduces the section of the tooth from the knee up by grinding the sides flat; consequently, after the wire has been plow-ground it must be either top-ground or needle-ground, in order to bevel the tooth and bring it to a point.

10. Diameter of Wire.—The diameter of the wire varies according to the class of cotton to be carded, since fine cotton requires clothing with a large number of points per square foot, while coarse work requires fewer points; and in the former case fine wire must be used, while in the latter case wire of a large diameter is more suitable. As will be explained later, it is customary to set the clothing with a certain number of points per square foot for a certain diameter of wire. There are two gauges employed for numbering wire; namely, the Birmingham, or Stubbs, which is the English standard, and the Brown & Sharpe, which is the American standard. The following table shows the comparative diameters, expressed in decimal parts of an inch, of different numbers of wire of each system:

TABLE I

Birmingham Diameter in Inches	Number of Wire	American Diameter in Inches
.014	28	.012641
.013	29	.011257
.012	30	.010025
.010	31	.008928
.009	32	.007950
.008	33	.007080
.007	34	.006305
.005	35	.005615
.004	36	.005000

For an average grade of cotton, No. 33 wire (American gauge) for the doffer and flats and No. 32 for the cylinder will give good results; for coarse work the wire is proportionally increased in diameter, and for finer work proportionally decreased. The cylinder should always be covered with wire one number coarser than the doffer and flats, which should have wire of the same diameter.

11. In regard to the shape of the tooth and the angle at which it is inserted in the foundation, several important points should be noted. The knee of the tooth should be located about four-sevenths of the length of the tooth from the crown and three-sevenths from the point. If the knee is placed higher the tooth will be stronger and have a harsher action on the cotton, while if the knee is lower the clothing will be more flexible and have a more brush-like action. The tooth should penetrate the foundation at an angle of about 75°, to offset the bend at the knee, so that the point of the tooth will not be too far forwards.
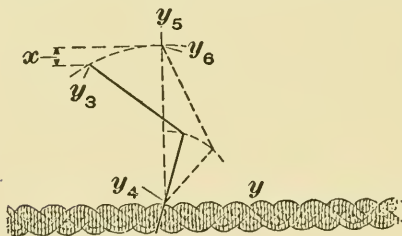
FIG. 4

The angle of insertion in the foundation and the bend of the knee should be such that the point of the tooth will just touch or very slightly pass a perpendicular line drawn from the point where the tooth emerges from the foundation. Should the forward inclination be such that the tooth passes the perpendicular to any great extent, the point of the tooth will rise when it is moved back by the strain of carding. This is more clearly shown by reference to Fig. 4. Suppose that the shape of the tooth is such that its point is inclined forwards past the perpendicular y_4, y_5, as shown at y_3; then when the strain comes on the tooth, the point will be moved back to y_6, owing to the flexibility of the tooth and the freedom of motion allowed by the foundation. The point, therefore, in swinging through the arc $y_3 y_6$ will rise through the distance x, which in the case of

a close setting might be sufficient to make the wire strike the clothing on other parts of the card. This action of the tooth is also aggravated by the tendency to straighten at the knee, so that even if no contact results, the setting will be made much closer and many fibers will be broken. On the other hand, if the inclination of the tooth does not carry its point past the perpendicular, the tendency of the tooth in moving backwards under the strain of carding will be to depress the point, making the setting more open and reducing the strain.
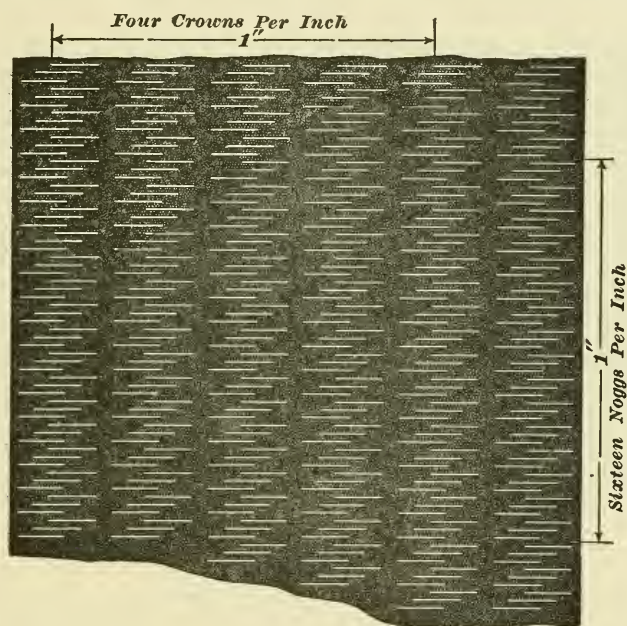
FIG. 5

CALCULATIONS

12. Card clothing for cotton cards is made in long continuous strips 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, and 2 inches in width known as **fillet,** or **filleting,** and in narrow sheets known as **tops;** the former is used for covering the cylinder and doffer, while the latter is used for the flats. Fillet clothing is made in what is known as **rib set;** that is, with the crowns of the teeth,

which are on the back of the clothing, running in ribs, or rows, lengthwise of the fillet. Fig. 5 shows the appearance of the back of a piece of $1\frac{1}{2}$-inch rib-set fillet, the horizontal lines indicating the crowns of the teeth and showing the method in which they are inserted. The teeth are set into tops so that the crowns of the teeth on the back side of the foundation are **twilled**; that is, they are set in diagonal lines like a piece of twilled cloth. Fig. 6 shows the appearance of the back of a top, the horizontal lines showing the method of twilling the crowns.

1"

Four Crowns Per Inch

Eight Noggs Per Inch
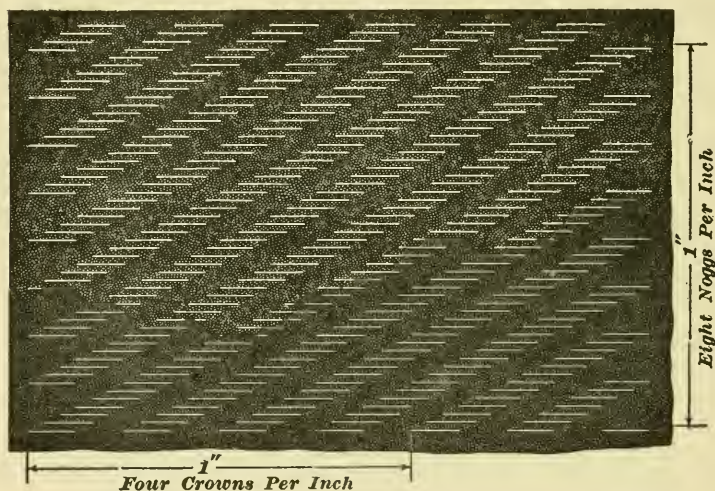
FIG. 6

All card clothing in America, unless especially ordered, is made with 4 crowns in 1 inch on the back of the clothing, or 8 points in 1 inch on the face, and is known as 8-crown clothing. From this it will be seen that a 2-inch fillet will have 8 ribs on the back and a $1\frac{1}{2}$-inch fillet, 6 ribs, etc. It should be noted that the actual width of the foundation of fillet clothing is about $\frac{1}{16}$ inch greater than the width of the wire-covered space; thus, a 2-inch fillet is actually $2\frac{1}{16}$ inches in width. Sometimes in special cases where a large number of points per square foot are desired, the clothing is made

10-crown; that is, with 10 points per inch in width on the face of the clothing, or 5 crowns per inch on the back of the clothing.

The term **nogg,** which is used in connection with card clothing, refers to the distance between the first tooth of one line of twill and the next line. It will be noticed in Fig. 6 that there are 6 teeth to a nogg and 8 noggs per inch, while in Fig. 5 there are half as many teeth per nogg and 16 noggs per inch. Owing to the manner in which the teeth are set in fillet clothing, there are always one-half the number of teeth per nogg and twice the number of noggs per inch as in clothing for tops with the same number of points per square foot. The number of noggs per inch always governs the number of points per square foot in the clothing. If more points per square foot are wanted, the noggs per inch are increased, while if fewer points are wanted, the noggs per inch are decreased, the crowns always remaining the same.

13. To find the points per square foot in card clothing:

Rule.—*Multiply the crowns per inch by the points per tooth (2), by the teeth per nogg, by the noggs per inch, and by the number of square inches in a square foot (144).*

EXAMPLE 1.—Find the points per square foot in the sample of card clothing shown in Fig. 5, the crowns per inch being 4, the teeth per nogg 3, and the noggs per inch 16.

SOLUTION.—

$$
\begin{array}{r}
4 \text{ crowns per in.} \\
2 \text{ points per tooth} \\
\hline
8 \text{ points per in.} \\
3 \text{ teeth per nogg} \\
\hline
2\,4 \\
1\,6 \text{ noggs per in.} \\
\hline
1\,4\,4 \\
2\,4 \\
\hline
3\,8\,4 \text{ points per sq. in.} \\
1\,4\,4 \text{ in. per sq. ft.} \\
\hline
1\,5\,3\,6 \\
1\,5\,3\,6 \\
3\,8\,4 \\
\hline
5\,5\,2\,9\,6 \text{ points per sq. in. } \textbf{Ans}
\end{array}
$$

Dividing the points per square foot by the noggs per inch, thus, $55,296 \div 16 = 3,456$, it will be noticed that with 8-crown fillet (4 crowns per inch) each nogg increases the points per square foot by 3,456. From this it will be seen that in order to find the points per square foot in 8-crown fillet clothing, it is only necessary to multiply the noggs per inch by 3,456

EXAMPLE 2.—Find the points per square foot in the sample of card clothing shown in Fig. 6, the crowns per inch being 4, teeth per nogg 6, noggs per inch 8.

SOLUTION.—

```
          4 crowns per in.
          2 points per tooth
          ───
          8 points per in.
          6 teeth per nogg
        4 8
          ───
            8 noggs per in.
        3 8 4 points per sq. in.
        1 4 4
      ─────
      1 5 3 6
    1 5 3 6
    3 8 4
    ─────────
    5 5 2 9 6 points per sq. ft.   Ans.
```

Dividing the points per square foot by the noggs per inch, thus, $55,296 \div 8 = 6,912$, it will be noticed that with 8-crown twill-set clothing each nogg increases the points per square foot by 6,912. From this it will be seen that in order to find the points per square foot in twill-set clothing it is only necessary to multiply the noggs per inch by 6,912.

In Table II is given the number of points per square foot of 8-crown, rib-set fillet (4 crowns per inch) with 3 teeth per nogg and with from 10 to 27 noggs per inch, and also shows the numbers of wire (American gauge) generally used in each case.

In Table III is given the number of points per square foot of 8-crown, twill-set clothing with 6 teeth per nogg and with from 5 to 13 noggs per inch and also shows the numbers of wire (American gauge) generally used in each case.

For an average grade of cotton the doffer should have 20 or 21 noggs per inch and the flats 10 or $10\frac{1}{2}$ noggs per

TABLE II

Noggs per Inch	Points per Square Foot	American Number of Wire
10	34,560	28
11	38,016	28
12	41,472	29
13	44,928	29
14	48,384	30
15	51,840	30
16	55,296	31
17	58,752	31
18	62,208	32
19	65,664	32
20	69,120	33
21	72,576	33
22	76,032	34
23	79,488	34
24	82,944	35
25	86,400	35
26	89,856	36
27	93,312	36

TABLE   III

Noggs per Inch	Points per Square Foot	American Number of Wire
5	34,560	28
6	41,472	29
7	48,384	30
8	55,296	31
9	62,208	32
10	69,120	33
11	76,032	34
12	82,944	35
13	89,856	36

inch, which in each case would give 69,120 or 72,576 points per square foot. For the main cylinder 18 or 19 noggs per inch are suitable, which would give 62,208 or 65,664 points per square foot. The number of points may of course be varied to suit the class of work, but it is generally desirable to have the same number of points in the doffer and flats,
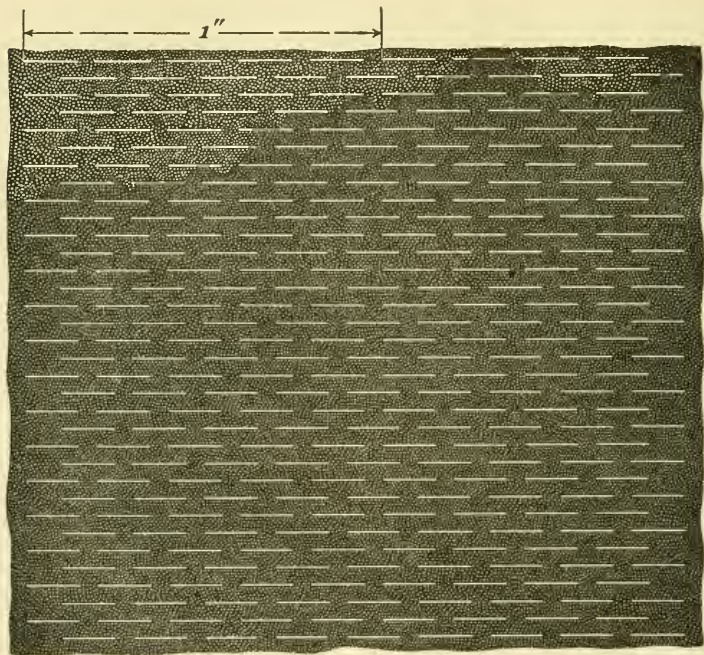
Fig. 7

while the main cylinder should have a slightly smaller number than either.

14. English Method of Numbering Card Clothing. English card clothing was formerly made with the teeth inserted according to a method known as the plain-, or open-, set, in which the crowns, or backs, of the teeth overlapped each other exactly as bricks in a wall, as shown in Fig. 7. The teeth were inserted in sheets 4 inches in width,

and the clothing was made with 5 crowns on the back, or 10 points on the face, in 1 inch lengthwise of the sheet, or crosswise of the card after the sheet had been applied to the same; that is, it was 10-crown clothing. Plain-set clothing is not often used in America, and although rarely used in England today, it forms the basis of the whole English system of numbering clothing. The English system designates card clothing by the **counts,** a term that indicates the number of points per square foot on the face of the clothing absolutely, but which gives no clue to the method of inserting the teeth, whether plain-, rib-, or twill-set; that is, 100s-count card clothing indicates a definite number of points per square foot and nothing else.

As stated, the English system of numbering card clothing is based on the 10-crown, plain-set clothing, the term counts indicating the number of noggs in 4 inches, which was the original width of the sheets. Thus, if a sheet of plain-set, 10-crown clothing had 60 noggs in its width, it was 60s-count, or if it had 100 noggs in the width of the sheet, it was 100s-count clothing, etc. As plain-set clothing was invariably made on the 10-crown basis, the number of noggs in the width of the sheet, or the counts, always indicated a definite number of points per square foot. For example, in 100s-count clothing, as there are 100 noggs in 4 inches, then in 12 inches, or 1 foot, there are 300 noggs, and as in plain-set clothing there are 2 teeth per nogg, there are $300 \times 2 = 600$ points crosswise of the sheets. Since 10-crown clothing has 10 points per inch, there are $10 \times 12 = 120$ points in 1 foot lengthwise of the sheet, which multiplied by 600 points per foot crosswise of the sheet equals 72,000 points per square foot. From this it will be seen that as 100s-count clothing contains 72,000 points per square foot, each count increases the points per square foot $72,000 \div 100 = 720$ points. Therefore, to find the points per square foot in card clothing of any counts, it is only necessary to multiply the counts by 720; and inversely, to find the counts of any card clothing, divide the points per square foot by 720.

Although plain-set, 10-crown clothing has been largely
superseded in both England and America by 8-crown, twilled-
set clothing for the flats and 8-crown, rib-set clothing for the
cylinder and doffer, the English system of numbering cloth-
ing is still based on the plain-set clothing, in which each
count is equal to 720 points per square foot.   Table IV
shows the points per square foot in card clothing of various
counts and also the number of wire (American gauge) that
is usually used.

TABLE IV

English Counts	Points per Square Foot	American Number of Wire
60s	43,200	28
70s	50,400	30
80s	57,600	31
90s	64,800	32
100s	72,000	33
110s	79,200	34
120s	86,400	35
130s	93,600	36

METHOD OF CLOTHING CARDS

CLOTHING FLATS

15.   The clothing for the flats is made in sheets with a
1-inch space between the sections of wire; these are after-
wards cut up to form the tops.   Formerly one of the most
difficult problems for cotton-card builders and manufacturers
of card clothing was to attach satisfactorily the top to the
flat.   The first method employed was to drill holes in each
edge of the flat and secure the clothing by rivets.   This
method, while it held the clothing securely, had a tendency
to weaken the flats, causing them to deflect; and in addition,
the cotton occasionally caught on the rivets until a bunch
was formed, which would pass into the card again and form

a nep in the web. Another method was to sew the top to the flat, but this was not entirely satisfactory.

The present method is to employ a steel clamp of the same length as the clothing and bent in a **U**-shape. One edge of this clamp in some cases is serrated, so as to grip the foundation, while the other edge engages the edge of the flat, holding the clothing and flat securely together. The foundation of the card clothing is pulled toward the edges of the flat and clamps applied simultaneously to both edges, so that the clothing is fastened while under tension. Afterwards end pieces are usually fastened on in order to make the clothing absolutely secure. The flats should be ground after the clothing is applied, so as to make them perfectly true.

***

CLOTHING CYLINDER AND DOFFER

16. Both the cylinder and doffer, which are covered with filleting, have parallel rows of holes drilled across them, which are plugged with hardwood. The fillet is wound spirally and secured by means of tacks driven in the hardwood plugs. Cylinders are usually covered with 2-inch, and doffers with $1\frac{1}{2}$-inch, filleting. Formerly it was customary to give the surface of the cylinder a thin coat of paint or cover it with calico before applying the clothing, but the present practice is to wind the fillet on the bare cylinder. The plugs should be flush with the surface of the cylinder, which should be smooth, free from rust, and perfectly dry before the clothing is applied. Since the fillet is wound spirally, it must be tapered at each end of the cylinder or doffer, so that it will not overlap.

17. There are several methods of shaping the *tail-ends*, as they are called, but the best is that known as the **inside taper,** since it is stronger and neater than any other. Fig. 8 (a) shows the method of cutting the fillet for an inside taper. Three lengths x, x_1, x_2, each equal to one-half the circumference of the cylinder or doffer, as the case may be, are first marked out on the end of the fillet; in the case **of** a 50-inch cylinder these distances x, x_1, x_2 would be
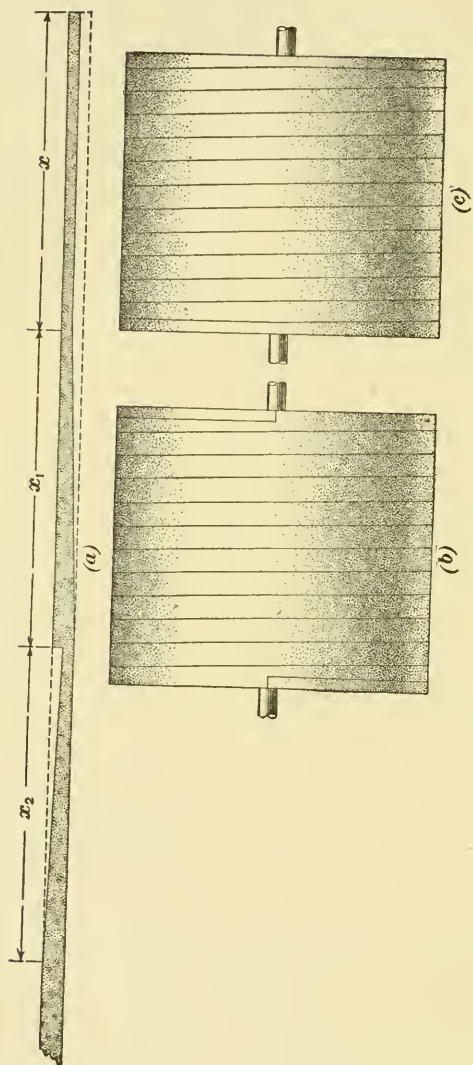
Fig. 8

6.545 feet each. For the first distance x, the fillet is cut exactly through the middle; for the second distance x_1, it is tapered from half the width of the fillet to the full width; for the distance x_2, a cut is made on the opposite side of the fillet exactly half way through it and the fillet tapered out to its full width again. The dotted lines in Fig. 8 (a) indicate the original width and shape of the fillet, while the full lines show the shape of the tail-end when cut. Fig. 8 (b) shows the method of winding the fillet on the cylinder and the way the tail-ends are fastened. After one tail-end is cut, the end of the fillet is tacked to the plugs in the cylinder and the fillet wound around the cylinder spirally, as shown in Fig. 8 (b) and (c); the other tail-end is then cut and fastened to the cylinder in the same manner as the first tail-end. Care should be taken in cutting each tail-end to have the straight, or uncut, edge of the fillet x, x_1 coincide with the edge of the cylinder. Fig. 8 (c) shows the opposite side of the cylinder shown in Fig. 8 (b).

18. To find the length of filleting to cover a cylinder, doffer, or other roll:

Rule.—*Multiply the diameter of the roll by its width (both expressed in inches) and by 3.1416 and divide the product thus obtained by the width of the fillet multiplied by 12. The result thus obtained will be the required number of feet of filleting.*

Note.—An allowance must be made for tapering the tail-ends, generally a length equal to the circumference of the roll being sufficient.

Example.—What length of 2-inch filleting is required to clothe a cylinder 50 inches in diameter and 40 inches wide?

Solution.— $\dfrac{50 \times 40 \times 3.1416}{2 \times 12} = 261.8$ ft.

Adding a length equal to the circumference of the cylinder, which is 13.09 ft., the length required will be 274.89 ft. Ans.

19. Fillet-Winding Machine.—Before applying the fillet, it should remain for several days in the room in which it is to be used; otherwise, it will have a tendency to expand after being fixed on the cylinder, which causes it to rise in

places.   The fillet is applied to cylinders or doffers by means
of special winding machines; formerly it was wound by hand.
Fig. 9 shows a good type of fillet-winding machine, which
consists primarily of a carriage a that slides on a bed b.
Sufficient motion is imparted to the carriage, by means of a
rotating screw c that engages with a gear c_1 on a shaft, to
guide the spirals of fillet close to each other.   The gear c_1
is prevented from turning, after the position of the machine
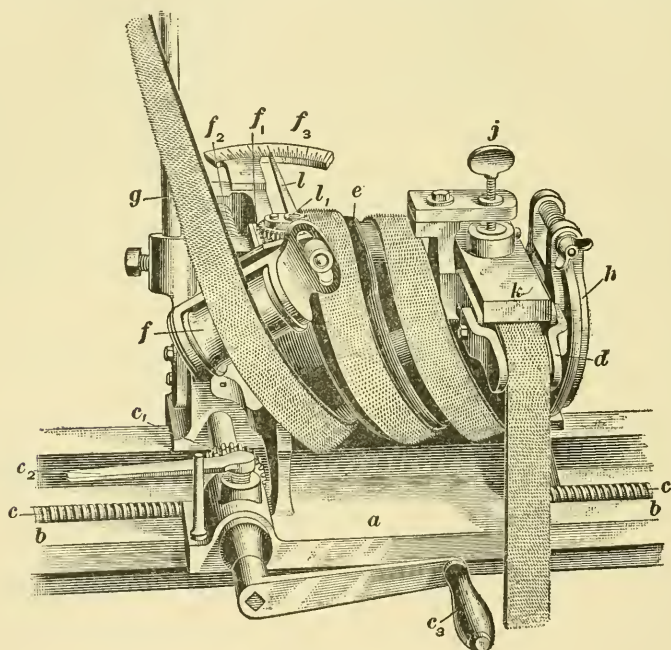
Fig. 9

is once adjusted with the crank c_3, by a lever c_2, which
operates a screw that secures its shaft.   The fillet when being
wound is usually placed in a basket, or other receptacle, from
which the end is taken and passed through the trough d to
what is known as the cone drum e, around which it is wrapped
three times.   The fillet emerges over the roll f and is guided
on the cylinder to be clothed by the rod g.   The fillet must
always be passed through the trough d so that the teeth will

point in the opposite direction to its motion; otherwise, they will be injured.

The tension is obtained in the following manner: The drum e, which revolves as the fillet passes over it, is made in three sections—the first $6\frac{1}{2}$ inches, the second 7 inches, and the third $7\frac{1}{2}$ inches in diameter. The section with the largest diameter is covered with leather, so that this portion of the drum and the fillet revolve together; and as it requires a greater length of fillet to cover this surface than it does to cover either of the smaller sections, the fillet is drawn over these at a speed greater than that of their surfaces, which will have the same effect as if the smaller sections were working in a direction opposite to that of the larger section. The friction between the fillet and the drum produces the tension on the former, the amount of which may be regulated by the brake h on the drum shaft and also by a thumbscrew j that presses the die k down on the fillet, which is drawn over a spring cushion in the trough d. About 200 pounds tension may be obtained by means of the brake h alone, the rest being obtained by means of the thumbscrew j. For main cylinders wound with 2-inch fillet, a tension of 270 to 300 pounds is about right; narrower fillet requires less tension. Doffers may have fillet applied with about 175 pounds tension. The amount of tension with which the fillet is being wound in this machine is indicated by a finger l on the dial f_3. This is accomplished by arranging the roll f to press against a strong coil spring f_2, connection being made with a rack f_1 and pinion l_1, so that the motion of the roll when acted on by the tension of the fillet is communicated to the finger and indicated on the dial.

In using this machine, it is essential that for each revolution of the cylinder being covered the carriage shall move along the bed a distance corresponding to the width of the fillet. This is accomplished by gearing the screw that imparts the traverse motion to the carriage from the cylinder being covered, the train of gears being so arranged that one tooth of the change gear moves the carriage $\frac{1}{32}$ inch to each revolution of the cylinder being covered. From this

it will be seen that $1\frac{1}{2}$-inch fillet will require a 48-tooth gear and 2-inch fillet a 64-tooth gear.   In actual practice, however, a 49-tooth gear is used for $1\frac{1}{2}$-inch and a 66-tooth gear for 2-inch fillet, since the fillet is wider than the nominal width and measures $1\frac{17}{32}$ inches and $2\frac{1}{16}$ inches, respectively.   A crank arrangement is usually applied to the cylinder and doffer so that they can be turned by hand while the clothing is being applied.

After cylinders are covered with fillet they should be allowed to stand for 3 or 4 hours in order that the fillet may become adjusted, when it should be tacked crosswise of the cylinder.

COTTON CARDS

(PART 3)

CARE OF CARDS

INTRODUCTION

1. The method of managing a card room very materially affects the quality of the product of a cotton mill, as in order to insure satisfactory results it is very essential that the carding process shall have careful attention. Care should especially be given to several important operations that must be performed at intervals.

Those parts of the card that are clothed—the flats, the cylinder, and the doffer—are constantly collecting waste from the cotton that is being operated on. This waste, consisting of short fiber and foreign matter that fills up the interstices of the card wire and prevents the card from doing its best work, must be removed at intervals from the clothing, the process being known as *stripping*. Fig. 1 is a view of a card showing arrangements applied for stripping the doffer and flats.

As the points of the card wire become dull, on account of the constant friction, and consequently do not card the cotton as satisfactorily as when sharp, they must be sharpened by means of emery rolls; this is accomplished by the process known as *grinding*. A view of a card, with arrangements applied for grinding the doffer and cylinder, is shown in Fig. 2.

When two wire surfaces are presented to each other, there
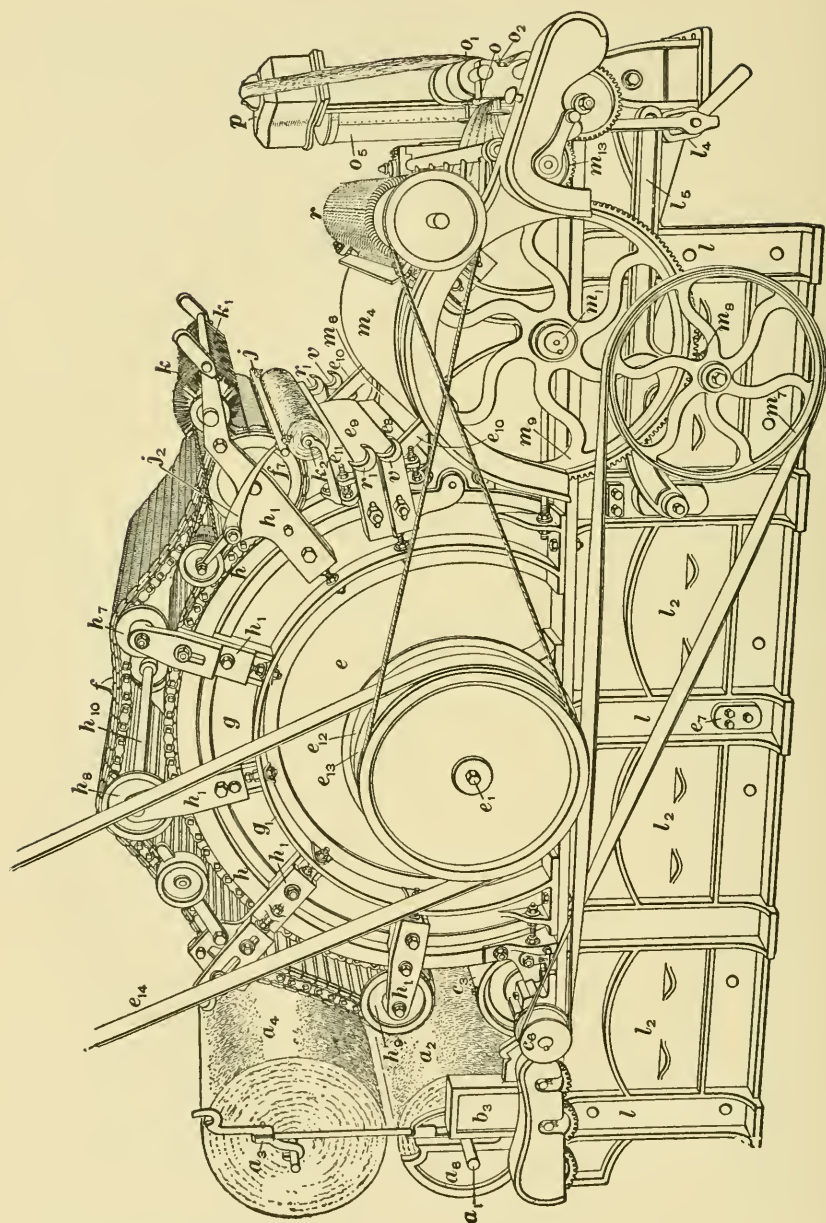
FIG 2
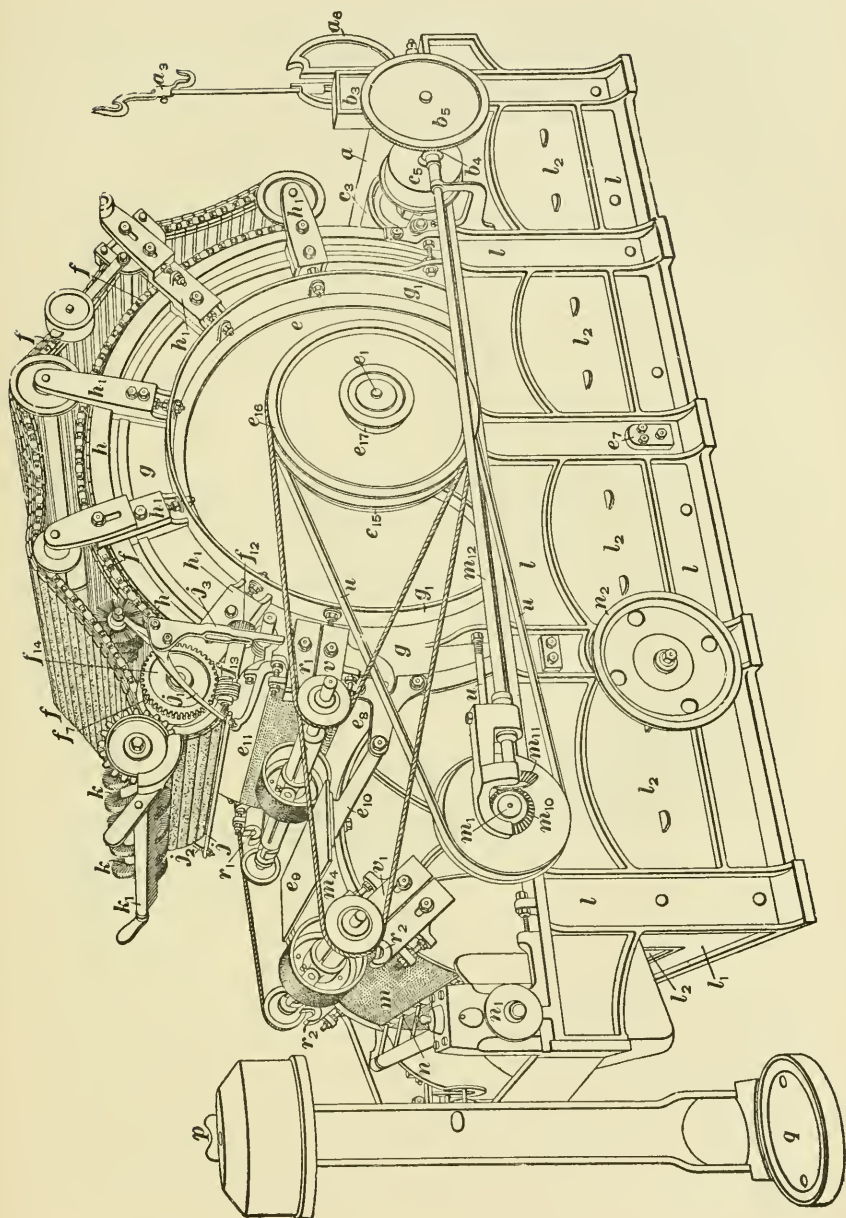
Fig. 2

is sometimes too much space between them, caused by parts of the card moving slightly out of position or by the shortening of the wire by the grinding process. The operation of regulating the distance between the two wire surfaces is known as *setting*.

In common with all machinery, the oiling of the parts must be periodically attended to, as well as the cleaning of the machine and the removal of fly from below the card. Very little more attention is necessary in connection with carding cotton with the revolving-top flat card other than keeping the machine supplied with laps and removing the cans when full.

STRIPPING

2. Methods of Stripping.—Various methods of **stripping** cards have been adopted. One of the earliest methods used in cotton carding, and one that is now in use in connection with woolen carding, was by means of a flat board from 4 to 6 inches wide and as long as half the width of the card, on the upper part of which a handle was attached, while a piece of card clothing was nailed on the lower part with the
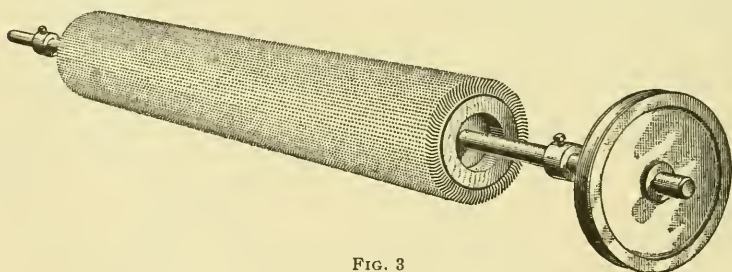
Fig. 3

points projecting toward the operator. The cylinder was slowly turned by hand, after it had been partly uncovered at the front, and the stripping card pressed into the wire of the cylinder and alternately pushed backwards and drawn forwards, the latter movement removing the waste from the cylinder. A similar operation cleaned the waste from the doffer.

A much better method of stripping the card and the one now commonly adopted is by means of a stripping roll, such as is shown in Fig. 3. This roll consists of a wooden cylinder mounted on an iron shaft and having wire clothing wound around it so as entirely to cover its surface, although on some rolls a narrow space without teeth is left from one end to the other. The clothing used for the stripping roll carries a very much longer tooth than that used to cover the cylinder or doffer, and the wire teeth are not set so closely together.

3. Frequency of Stripping.—The number of times that a card should be stripped within a stated period will be found to vary, but it may be said to depend on two factors. One is that the greater the weight of cotton that is put through the card per day, the more frequently it should be stripped; the other is that in fine work the clothing should be kept as free as possible from short fiber and particles of foreign matter, so that when running fine work the card should receive more frequent stripping, notwithstanding the fact that a lighter weight of cotton is being put through the card than in coarse work. It may be stated as a common practice that for fine work the card should be stripped three times a day unless a very large production is being obtained, when it is advisable to strip four or even five times per day, while with a medium production and where a very high grade of work is not called for, it is not necessary to strip the cylinder and doffer more than twice a day.

To stop a card for stripping purposes necessarily means a reduction in the amount of product, but by carefully planning so that the card will not be stopped any longer than necessary before it is stripped, and by getting it in operation again immediately after stripping, the loss can be reduced to a very small amount. In stripping cards two men are usually employed, since one cannot readily handle the long stripping roll; and time can also be saved by having one man preparing the next card for stripping while the other man is performing the operation of restarting the card previously stripped and removing the strippings from the

stripping roll. Since it is the usual practice to strip the cylinder before stripping the doffer, time may also be saved by starting the feed while the doffer is being stripped. In this manner the cylinder will be filled and the sliver will be ready to be pieced up as soon as the stripping action is completed. In order to economize in the amount of strippings removed from the card, the feed-roll and calender rolls should be stopped a short time before the card is stopped, thus allowing the good cotton to run through the card and drop on the floor in front of the doffer; it is then removed and returned to the mixing room.

4. Operation of Stripping.—The operation of stripping is as follows: The card is first stopped by shipping the driving belt from the tight to the loose pulley. The feed-roll should have been previously stopped by disengaging the side shaft m_{12}, Fig. 2, at the doffer, and the gear m_{13}, Fig. 1, should also have previously been thrown out of gear by means of the handle, thus stopping the calender rolls and coiler and allowing the good cotton to run through the card until exhausted, as previously stated. As the cylinder is the first to be stripped, the cover, or door e_9, that protects the cylinder at the front and is hinged on the arms e_{10}, is lowered so as to leave the cylinder bare at that point. The stripping roll is now placed in the upper set of bearings r_1 and a band run from the outer groove of the loose pulley of the card to the grooved pulley on the end of the stripping roll. This band should be crossed in order to give the correct direction of motion to the stripping roll. With the stripping roll in this position its teeth should project a slight distance into the wire of the cylinder, usually about $\frac{1}{8}$ inch, and should point in the direction of revolution of the roll. At the point where the roll is in contact with the cylinder, the teeth of both are pointing in the same direction and the surface speed of the roll is greater than that of the cylinder, thus making the stripping possible. The driving belt of the card is now moved sufficiently on to the tight pulley to turn the cylinder slightly and at the same time leave

enough of the belt on the loose pulley to give the necessary power to drive the stripping roll.

It is advisable for the operator to be able to control the speed of the stripping roll at all times and to stop it suddenly if necessary. On this account the band that runs from the loose pulley to the stripping roll is not usually tight, the stripper creating sufficient tension to drive the stripping roll by pressing his hand on the band. By this means the wire teeth on the rapidly revolving stripping roll remove the waste from the spaces between the teeth of the card wire on the cylinder, this waste adhering to the surface of the stripping roll. In performing this operation, care should be taken that the cylinder does not attain a greater surface speed than the roll, since in this case the excess surface speed of the cylinder will cause the waste to be taken from the roll by the cylinder.

After the cylinder has made one complete revolution, the band that drives the stripping roll is removed and the stripping roll taken from the stands r_1 and cleaned and then placed in lower stands at the doffer, as shown in Fig. 1. A band somewhat longer than the one previously used is then run from the loose pulley of the card to the grooved pulley on the stripping roll r. This band is also crossed, and the operation of stripping the doffer is performed in the same way as that of stripping the cylinder. It is the practice in some mills, especially those making coarse counts, to run the card while stripping the doffer. This, however, is not good practice, since the stripping roll throws out considerable dirt, a good part of which is liable to drop into the web and be carried through into the finished sliver.

5. Cleaning the Stripping Roll.—After stripping the cylinder of each card, and also the doffer, the strippings retained by the stripping roll should be removed from the stripping roll. These strippings may be removed by a hand card or by placing a finger in the narrow space that is without wire teeth, when one is left in the stripping roll, breaking the circular web at this point, and unrolling it from

the roll. Another method of removing the strippings from the stripping roll and one that is used in a large number of mills is to employ a box that is placed on wheels. This box is usually about 18 inches wide, 3 feet deep, and long enough to allow the clothed part of the stripping roll to rest between its ends, while the ends of the shaft rest in **V**-shaped grooves in the ends of the box. A strip of wood about 4 inches wide covered with card sheets is fixed between the ends of the box in such a position below the stripping roll that the wire teeth of the roll will just enter the wire of the sheets when the shaft of the roll is set in the grooves in the ends of the box. When cleaning the roll, it is turned by hand with a backward and forward movement, which causes the strippings to be removed and dropped into the box. This method is quicker and better than the hand card and provides a place for keeping the roll. The box also serves as a receptacle for the strippings.

It will be noticed that a card immediately after being stripped produces a sliver slightly lighter in weight, which is due to the spaces between the teeth of the clothing filling up again with fiber. In mills where it is desired to make exceptionally even yarns it is not advisable to strip at one time all the cards supplying one subsequent machine, but to take them in sections of either two or four supplying different machines.

GRINDING

GRINDING ROLLS

6. Grinding is the process of sharpening the teeth of the card wire on the cylinder, doffer, or flats by means of rolls called **grinding rolls,** and is of great importance in connection with carding. Formerly when mild-steel wire was used grinding had to be performed frequently. The clothing, however, that is almost universally used at the present time is made of hardened-and-tempered-steel wire that is ground on the sides after having been inserted

through the foundation; consequently, the tooth is almost wedge-shaped, so that even when the extreme point is worn away there still remains a comparatively sharp tooth. Grinding is therefore required less frequently than formerly, not only because the hardened-and-tempered-wire retains its point longer, but also on account of the shape of the tooth.
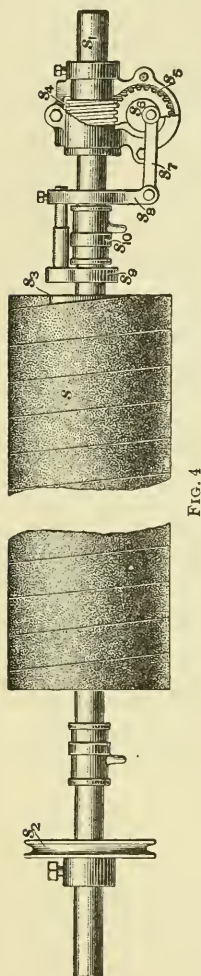
Fig. 4

7.   Dead Rolls. — Grinding rolls are of two kinds—the *dead roll* and the *traverse grinder*. The **dead roll** is shown in Fig. 4. It consists principally of a hollow shell s mounted on a shaft s_1. This shell is covered with emery fillet wound spirally on its surface. At the ends of the shell, where the fillet tapers to a point it is passed through slots, one of which is shown at s_3 and is firmly fastened by means of a steel clip setscrewed to the inner side of the shell. A dead roll suitable for grinding purposes on a 40-inch card is about 42 inches long and $6\frac{3}{4}$ inches in diameter.

When grinding, the dead roll is given a slight traversing motion and grinds the back of the teeth with a slight tendency toward grinding the sides. The traversing motion is obtained in the following manner: The shaft that carries the shell s projects beyond both ends of the shell sufficiently to carry at one end the worm s_4 and at the other end the pulley s_2, through which the roll receives its rotary motion; this pulley is driven by a band that passes around the grooved pulley on the end of the cylinder shaft of the card. The worm s_4, which is fast to the shaft s_1, drives a worm-gear s_5 that carries a pin s_6 set away from the center of s_5 and loosely connected to the rod s_7, the other end

cf the rod being connected to the bracket s_8, which is loose on the shaft s_1. Connected to the bracket s_8 by means of a short rod is another bracket s_9, that is loose on the shaft s_1. The two brackets s_8, s_9 enclose a brass bushing s_{10} that rests in one of the bearings for the grinding roll when the roll is in position, while a similar bushing on the other end of the shaft rests in the other bearing. Pins on these bushings project into holes provided in the bearings and thus hold the bushings firmly in one position. These bushings are loose on the shaft s_1; consequently, the shaft is free to revolve and also to move laterally. With this construction, it will be seen that as the worm s_4 drives the worm-gear s_5, the latter, acting as an eccentric because of the position of the pin s_6, will tend to impart a reciprocating motion to the brackets s_8, s_9 through the connecting arm s_7, but will be prevented from doing so on account of these brackets being held in one position by means of the bushing s_{10}. Since the brackets are stationary, the rod s_7 and the pin s_6 that connects it with the gear s_5 can have no lateral movement; consequently s_5, by its eccentric movement around s_3, will, through its bearing in the gear-cover, a portion of which is shown broken away in Fig. 4, and through the collars on the shaft at each side of the cover, impart a traversing movement to the shaft s_1 and the roll s. Dead rolls are used for grinding the flats of the card, but seldom for grinding the cylinder or doffer, it being the custom to grind these two parts with the dead roll only when they have been newly clothed or when their surfaces become very uneven.

8. The Traverse Grinder.—The second type of roll, known as the **traverse grinder,** or sometimes as the **Horsfall grinder,** is shown in Fig. 5. It consists of a roll t about 4 inches wide covered with emery fillet and mounted so as to slide on a hollow barrel, or shell, of large diameter. Inside the barrel is a shaft containing right- and left-hand threads connected at the ends. A fork t_1 fits into these threads, and a pin that projects from it passes into
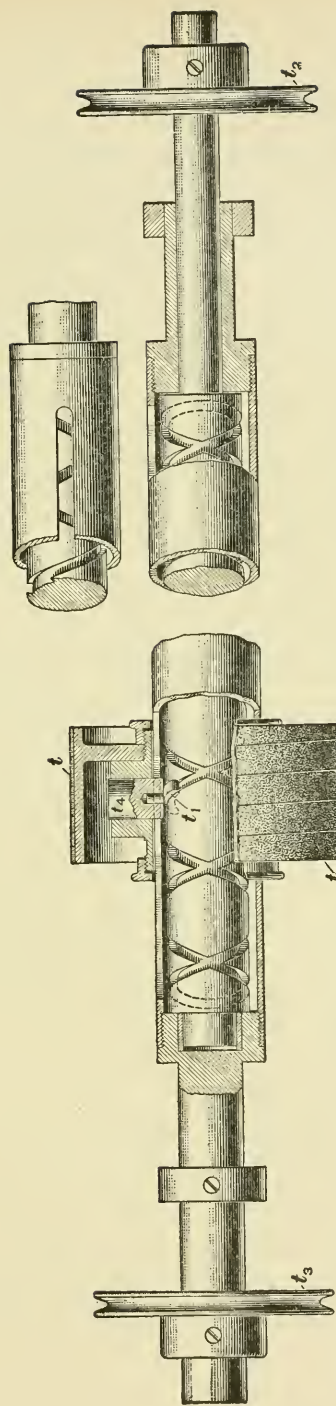
FIG. 5

another pin t_4 that projects into a straight slot in the outer barrel and enters the roll. There are two pulleys, one of which t_2 is on the inner shaft, while the other t_3 is on an extended portion of the barrel. With this construction the barrel is rotated when t_3 is driven; the pressure of the edge of the slot against the pin t_4 when the barrel is revolved causes the grinding roll also to revolve. A traverse motion is also imparted to the roll t by driving the pulley t_2, which causes the fork t_1 to be moved from side to side, changing from one thread to the other at each side of the card. Since the grinding roll presses against the clothing, the result of its traverse motion is to cause the teeth that are in contact with it to be bent, or inclined, toward the side of the card to which the roll is moving. The result of this is that the sides of the points of the teeth are ground down slightly, as well as the top of the points. In consequence of the roll being so narrow, it requires a longer time to grind the card with this mechanism than with the dead roll, other conditions being the same, but the results are so much better that it is very largely used. There is an unavoidable dwell on each side, which tends to grind down the sides rather more than the center; this is the only other important disadvantage in the use of this grinder.

Grinding rolls, whether traverse grinders or dead rolls, are usually covered with emery fillet; this is a tape 1 inch wide covered on one side with emery, and is supplied in lengths of about 300 feet. It can be obtained with emery of different degrees of coarseness or fineness, the kind generally used for card grinding being known as No. 40.

PREPARATION FOR GRINDING

9. All grinding is usually performed by a man known as a **grinder**, who in large mills has from twenty to sixty revolving-top flat cards under his charge. The cards are usually ground in turn, unless some accident or defect necessitates some card to be ground out of the regular order. Before the grinding takes place, however, the card must be

prepared for this purpose, and the operation is somewhat as follows: The lap is either broken off at the back and the end allowed to run through, or more usually the side shaft m_{12}, Fig. 2, is disengaged and the feed-roll turned backwards by turning the plate bevel gear b_5 in the opposite direction from that in which it usually revolves. This rolls up the sheet and takes the fringe of cotton away from the licker. Any cotton in the card is allowed to run through and the cylinder and doffer are then stripped clean of short fibers, care being taken that no cotton remains on the part stripped. The card is then started and the flats allowed to run bare of all strippings; this takes from 25 to 40 minutes, according to the speed of the flats and nature of the cotton being carded. The card is then stopped and the fly taken out from under the card and from between the sides of the cylinder and framework and between the sides of the doffer and framework, where it collects. Card makers have in late years greatly lessened this space and in so doing partly reduced the amount of fly at these points. This waste is sometimes called **cylinder-end waste**, and is removed from these parts by means of a long, thin hook usually made from a bale tie. Fly also collects around the shaft that connects the sprocket gears that drive the flats. Care should be taken to remove all loose fly from around and under the card before grinding is commenced. If any remains there is great danger of fire, as sometimes the grinding roll strikes sparks.

After making certain that the gear m_{13}, Fig. 1, and the side shaft, m_{12}, Fig. 2, which were thrown out of gear before stripping, are well out of contact, disengage the doffer and barrow gears by throwing up the front end of the catch l_4, Fig. 1, which will drop the lever l_5 that supports the barrow gear. The licker belt, flat belt, and comb bands may then be removed. In some cases, when grinding, it is necessary to remove the pulley on the shaft with the worm that drives the flats, in order to accommodate the bands that are placed on the card for grinding, but where this is not necessary the flats should always be run with their driving belt reversed, so that when the direction of rotation of the

cylinder is changed for grinding, as described later, **the flats** will move in the same direction and at the same speed as when carding. If the flats are stationary during the grinding process they will be filled with dirt by the cylinder, and the first cotton that is put through the card after grinding will have to be considered as waste on account of the unclean condition of the flats.

During grinding, the cylinder is driven at the usual speed but in the opposite direction to that in which it is driven for carding purposes. It is necessary to reverse its direction in order that the back of the tooth may be presented to the grinding roll when grinding. If the front of the tooth were presented to the grinding roll, the tooth would be beveled off at the front, which is directly the reverse of what is desired; in addition to this, the grinding roll acting on the front of the tooth would tend to raise it from its foundation and cause it to stand higher than it should. In order to reverse the direction of the cylinder it is necessary to cross the driving belt, if it was previously open; but if the belt for driving the cylinder when carding was crossed, it is simply necessary to have the belt open when grinding. If it is necessary to cross the belt when grinding it will be somewhat tight; to avoid this it is sometimes the custom to use an extra belt of the right length, which is carried from card to card by the grinder, although the same belt is more often used for both grinding and carding. In this case, if the belt was crossed when carding it must be taken up when used for grinding. This is accomplished by punching two holes in a line crosswise of the belt and two holes similarly placed but a short distance from the first holes and inserting a lacing of horsehide, thus forming a loop in the belt. The distance between these two pairs of holes depends on the amount of slack that it is necessary to take up in order to drive the cylinder with an open belt.

The doffer when being ground is driven in the same direction as for carding purposes, but at a higher speed, by a special belt u, Fig. 2, from a pulley on the cylinder shaft. By these arrangements both the cylinder and doffer revolve

with the wire pointing in the opposite direction to the direction of motion.

10. After making sure that everything is clear of the cylinder and doffer and that the belts for driving them are properly adjusted, the card is started. The cylinder and doffer are then brushed by means of a brush about 2 feet long and 3 inches wide, which is held in contact with the cylinder and doffer wire by the operative and moved from side to side of the card, thus removing all dust from the interstices of the wire. The card is then allowed to run a few minutes to remove from the flats the dust that has lodged there when brushing the cylinder and doffer.

Next the card is stopped and the grinder removes such covers and bonnets as are necessary to be removed. The grinding roll for the cylinder is then placed in the stands v, Fig. 2, with the pulley that gives the traversing motion to the roll on the same side as the main driving belt of the card. A band for giving the rotary motion is put on the pulley t_3, Fig. 5, of the grinding roll and around one of the grooves of the pulley e_{16}, Fig. 2, on the cylinder shaft. The grinding roll for the doffer is now placed in position in the stands v_1 in the same manner as the cylinder grinding roll. A band is passed around the pulley t_3, Fig. 5, and around the other groove of the pulley e_{16} on the cylinder shaft.

The pulley t_2, Fig. 5, on the opposite end of the grinding roll imparts the traversing motion to the roll t. A band that passes around the grooved pulley compounded with the tight pulley on the cylinder shaft passes around the pulley t_2 on the doffer-grinding-roll shaft and also over the pulley t_2 on the cylinder-grinding-roll shaft, thus imparting motion to the latter by slight friction only. In some cases an extra pulley is placed on the shaft of the doffer grinding roll and a band passed from this pulley around one of similar size on the shaft of the cylinder grinding roll, thus giving a more positive traversing motion. The former method of imparting the traversing motion to both rolls is not very satisfactory, as the cylinder roll does not receive as positive a

motion as it should, owing to the small portion of the pulley that comes in contact with the band.

It is possible to use one bracket for carrying both the stripping and the grinding rolls, but it is very inconvenient, as the wire of the stripping roll should project a short distance into the wire of the cylinder or doffer, while the surface of the grinding roll should only lightly touch the points of the wire on the cylinder or doffer; consequently, the distance from the center of the shaft to the surface of the roll will be different in each case. Even if the two rolls are arranged at first so that the necessary distances are obtained, the wire on the stripping roll will wear down more quickly than the emery on the grinding roll, and thus it will be necessary to adjust the brackets when changing from one roll to the other. Consequently, it should be ascertained which bracket must be used for each purpose, and in operating the card this fact should be remembered.

OPERATION OF GRINDING

11. Grinding the Cylinder and Doffer.—After having placed the grinding rolls in their stands, and usually before the proper bands are adjusted, the grinder proceeds to set the grinding roll to the wire on the cylinder and doffer. In performing this operation it is generally first necessary to use a card gauge, in order to make sure that neither grinding roll is pressing too heavily on any part of the cylinder or doffer. After this the proper bands are adjusted, the card is started and the grinder determines the actual setting of the grinding rolls to the wire by placing his ear as close as possible to the point at which the grinding roll comes in contact with the wire and judging by the amount of sound that is made whether either grinding roll is in its correct position. In light grinding, which is preferable, only a light buzzing sound should be distinguished, and care should be taken that this is the same at all points on the cylinder or doffer. When setting the grinding rolls, the brackets that support them are adjusted by means of nuts and setscrews provided for that purpose.

During the grinding operation, the grinding roll of both the cylinder and the doffer is rotated at a speed of from 800 to 900 feet per minute; the cylinder is making about 2,150 feet per minute, while a point on the surface of the doffer will move about 1,866 feet per minute in the card under consideration. The direction of the rotation of the cylinder and the doffer, and the inclination of the teeth are such that the grinding roll grinds the back of the teeth. At the same time, because of its traversing motion, it also grinds the sides as has been explained. The grinding roll does not merely touch the wire but produces a slight pressure on it, which tends to force the point of the wire forwards toward the foundation of the clothing; consequently, if the roll grinds on one portion longer than the other, the wire will be lower in this place. This is more liable to occur with the traverse rolls at the edges of the cylinder and doffer, where the rolls have a slight dwell during the reversing of the traverse. If possible this reversing should take place almost beyond the edges of the cylinder and doffer, and grinding stands are now set wide enough to allow a longer roll to be used, which permits the disk to traverse almost off the wire while reversing. After the card is ground, the grinder removes the grinding rolls and brushes out the cylinder and doffer clothing, for the purpose of removing all small pieces of steel or emery caused by the grinding. After stopping the card, the grinder removes the belt driving the doffer, makes the necessary settings, changes the driving belt, and replaces all belts, bands, and parts that were either removed or changed in position to prepare the card for grinding; he then puts on a lap and starts up the card.

The length of time required for grinding depends to a great extent on the condition of the wire, since if the points of the teeth are dulled considerably, a longer time will be required than if the clothing is in comparatively good condition. The degree of coarseness of the emery on the grinding roll also governs to some extent the time required for grinding, since coarse emery cuts much faster than fine

emery. The time required for grinding is also governed by the amount of pressure exerted by the grinding roll on the clothing. If the grinding roll is set so that it presses heavily on the wire, the grinding will be accomplished in less time, although there is more danger of injuring the wire; such grinding is known as *heavy grinding*. If the grinding roll presses only lightly against the clothing, a greater time will be required to secure the proper point on the teeth, but there is less danger of injuring the wire; this method of grinding is spoken of as *light grinding*.

The temper of the wire with which the card clothing is set also affects the length of time required for proper grinding, since hardened and tempered wire grinds more slowly than soft wire.

As a general rule it may be stated that from one-half to one working day, or from 5 to 10 hours, is the usual time required for properly grinding the cylinder and doffer of a card.

The interval between the times of grinding depends somewhat on the product of the card, the condition of the wire, and the opinion of the person in charge. Generally speaking, it is advisable to grind frequently and lightly for a long time rather than at more remote intervals and heavily for a short time, as the former method is not so liable to heat the wire and to take out the temper. If the cards are turning off an average production for medium counts, grinding the cylinder and doffer once in every 20 or 30 days will be found sufficient. In many mills they are not ground so frequently.

12. Grinding a New Card.—A card that has been newly clothed requires grinding before being used for carding purposes, and this first grinding operation will be found to differ somewhat from the usual method of grinding, the object being to render the surface of the cylinder and doffer perfectly level at all points. If the fillet is not put on with a regular tension it is liable to rise, or blister, at places, and if the tacks that hold it have not been driven with care the wires around them will be high. Sometimes the edges of

the fillet are allowed to overlap slightly or the fillet is crowded too closely, thereby causing the wire to be higher in some places than in others. If the card is carefully clothed these faults should not occur to any extent, but when they do those wires that are higher than the others must be ground level with the rest of the surface. A newly clothed card is first ground with dead rolls, which are left on until the surface of the wire on the cylinder and doffer is perfectly smooth; this takes from 3 to 10 days. After the wire has been ground level by means of the dead rolls, the traverse rolls are used for the purpose of putting a point on the wire and are left on about a similar period, the length of time depending on the temper of the wire and also on the length of time that the wire has been ground by the dead rolls.

13. Grinding the Flats.—The card wire on the flats requires grinding periodically, and while some portions of the preceding description and remarks apply to grinding in general and can be applied to the grinding of the flats, there are special features in connection with this process that make it differ somewhat from the grinding of the cylinder and doffer. The fact that the flats are arranged in an endless chain and slide for a portion of their movement on a smooth, circular arc, while at another portion of their circuit they are carried over rolls on which they are suspended, prevents their being driven past the grinding roll at the same speed as the card wire on the cylinder or doffer. On this account and also because there are, during the running of the card, a number of the flats that are performing no actual work for a considerable length of time, it is customary to grind the flats while the card is in operation and with the flats moving at their working speed, which saves a loss of time and production. This slow movement of the flats, since only one flat is ground at a time, causes considerable time to elapse before all the flats can be brought under the action of the grinding roll. The dead roll is almost always used for grinding the flats and is placed in brackets on each side of the card. These brackets are so adjusted that the roll,

when resting in them, will lightly touch the wire of the flats
as they pass from the front to the back of the card; that
is, it grinds the flats while they are suspended by the bracket
over which they move. An arrangement is adopted to
firmly support the flat while it is being ground, and at the
same time hold it in such a position with relation to the
grinding roll that the heel of the flat will not be ground off.
When the flats are at work the heel is closer to the card wire
on the cylinder than is the toe, and if this relative position
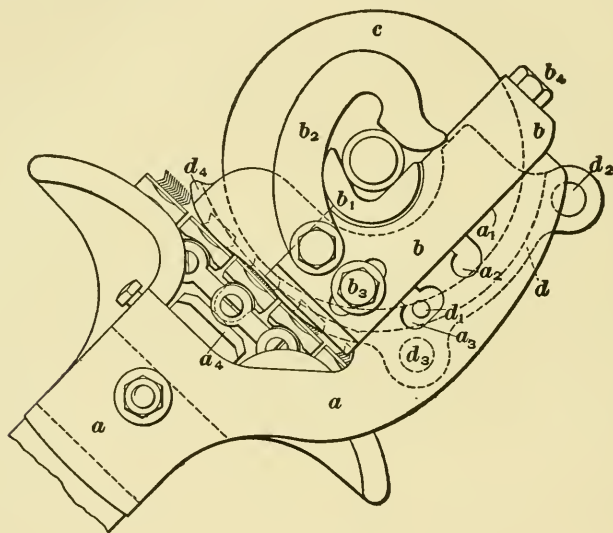
Fig. 6

were not preserved with regard to the grinding roll, **the wire at**
the heel would be ground off before the wire at the toe was
touched by the grinding roll.

14. One type of grinding apparatus is illustrated in
Figs. 6 and 7; Fig. 6 shows the grinding apparatus in posi-
tion, while Fig. 7 is a perspective view of some of the
essential parts. The bracket a that supports the different
parts is firmly attached to the side of the card, there being a
bracket on each side. Resting against the inclined sur-
face a_1 of the bracket a is a casting b that carries the

bearings b_1 for the grinding roll c. Attached to this casting is a finger b_2 that serves to lock the grinding roll firmly in position. The casting b is firmly secured to the piece d and can be adjusted by loosening the nut b_3 and turning the set nut b_4, thus moving the grinding roll nearer to or farther from the teeth of the flats, as may be desired. A pin d_1 that is carried by d may be set in either of the slots a_2, a_3 cast in the bracket a. At its lower part the piece d carries the former d_4, which is so shaped that if it is pressed firmly against the end of
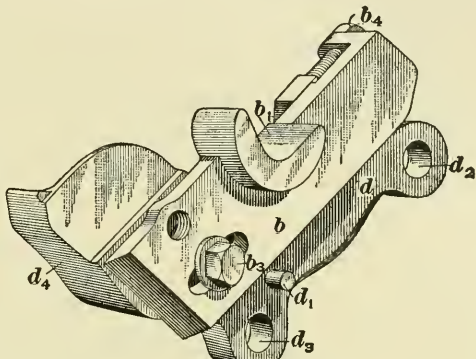
Fig. 7

the flat, the wire surface of the flat will be presented in such a position to the grinding roll that the flat will be ground evenly across its width. These parts are, of course, duplicated on the other side of the card, and rods that serve to connect the two sides at the points d_2, d_3 extend across the card, the entire mechanism being known as the cradle.

The parts mentioned form the principal parts of this mechanism and its operation is as follows: When the cradle is in position for grinding, the pin d_1 on d projects through the slot a_3 of the bracket a, but it should be clearly understood that during grinding, d is not supported by the bracket, since the weight of all the parts is made to bear on the ends of the flats, which during this time are supported by the bracket a_4, attached to the bracket a. In this manner, each flat during its movement from the front to the back of the card is brought between the bracket a_4 and the former d_4, against which it will be rigidly held; the former d_4 is milled in such a manner as to cause the flat to assume its correct position in relation to the grinding roll and to be held in this position until it has passed entirely from under the action of

the grinding roll. When this grinding arrangement is not in use it may be raised and the pin d_1 inserted in the slot a_2, thus bringing all the parts out of contact with the flats; or when it is desired, all the parts may be removed to another card for the purpose of grinding.

15. Another device for holding the flats in the correct position for grinding is shown in Figs. 8 and 9; Fig. 8 shows the mechanism as it appears when looking at the side of the card, while Fig. 9 shows certain of the parts as viewed from
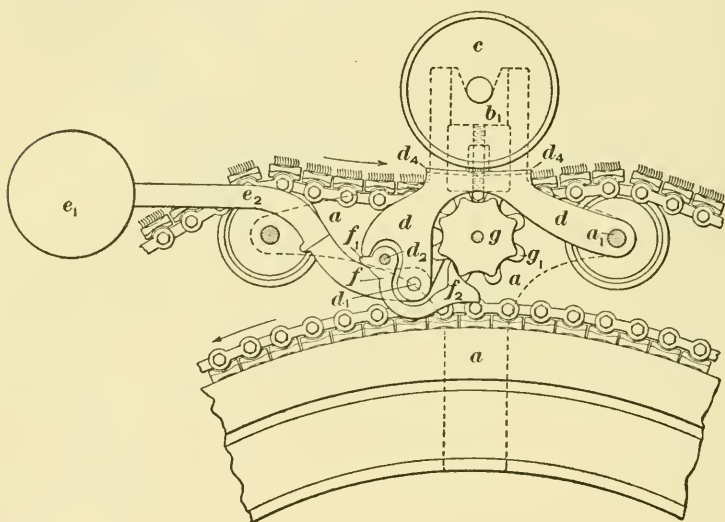
Fig. 8

the inside; consequently, one view is the exact reverse of the other. These parts are duplicated on each side of the card, but as they both work exactly alike only one will need a description. The grinding roll c is placed directly over the center of the cylinder and rests in the bearing b_1 supported by the stand a, which is firmly attached to the framework of the card. In the illustrations, the bearing b_1 and stand a are indicated by dotted lines in order to leave an unobstructed view of the interior parts. Pivoted to the stand a at the point a_1 is a casting d, the upper part of which projects

sufficiently to come directly over the outer ends of the flat,
and constitutes the former d_4. If the flat is forced against this
projecting piece, or former, the teeth will assume the correct
position for grinding. Pivoted to the casting d at the point d_1
is a lever e_2 that carries at its outer end a weight e_1, while
the inner arm e of this lever bears against the under side of
the flat. Pivoted to the bracket a at the point d_2 is a lever f
that carries a shoulder f_1 that bears against a projection on
the casting d. At its other end, the lever f has a projecting
finger f_2 that bears against the cam g. Compounded with
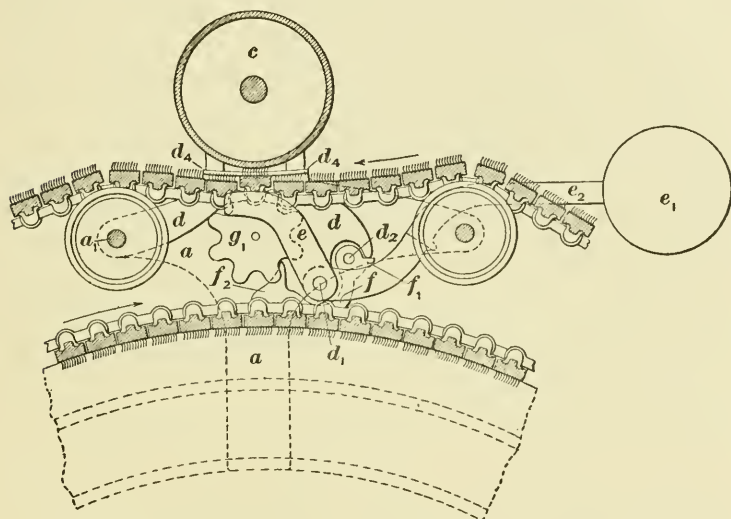
Fig. 9

the cam g is a sprocket gear g_1, the teeth of which engage
with the ribs on the backs of the flats.

The operation of this mechanism is as follows: The flats
move continuously, the upper line being face up and moving
in the direction indicated by the arrow. The movement of
the flats causes the sprocket gear g_1 to revolve on its stud,
and since the cam g is compounded with the sprocket gear,
it will revolve also. The projection f_2 of the lever f is held
in contact with the face of the cam by the pressure of the
casting d on the shoulder f_1; consequently, as the cam revolves

and one of the high portions of its face comes in contact with the projection f_2, it will force the projection f_2 downwards, and allow it to rise again when one of the low portions of the face of the cam approaches. This movement of the lever f causes the casting d and former d_4 to be alternately raised and lowered to a slight extent.

As the flats move in the direction indicated by the arrow, a portion of the rib of each comes in contact with the upper surface of the arm e, which tends to raise each flat but is prevented from doing so by the former d_4; consequently, the flat is practically locked between these two parts, although its movement in the direction indicated by the arrow is not prevented. As the former d_4 is raised the flat that is thus locked is carried upwards until it assumes its proper position for grinding, which is controlled by the cam g and the former d_4. After the flat has moved sufficiently to be free from the action of the grinding roll c, the former d_4 and arm e are lowered to allow another flat to be brought into position to be raised and ground. This operation is continued throughout the grinding of each flat in the entire set. The lowering of the former and arm allows each flat to be brought into position before being raised in contact with the grinding roll, thus insuring that each flat will occupy its proper position before coming under the action of the grinding roll.

16. Owing to the fact that the flat when performing its carding action is supported at each end only, and also on account of its length being so much in excess of its width, there is a tendency for the flats to bend downwards, or deflect, in the center. The rib forming the back of the flat is so shaped as to reduce the amount of deflection to a minimum, but it cannot be altogether overcome. It will thus be seen that if the flats are ground perfectly level when the wire is upwards, the surface when reversed, that is with the wire downwards in position for carding, will be slightly convex and consequently the ends of the flats cannot be set so close to the cylinder as their centers. To overcome this difficulty and also to avoid dirt and pieces of emery dropping on the

cylinder, which sometimes occurs when the grinding takes place above the cylinder, the flats are sometimes ground in their working position.   Such a method is shown in Fig. 10. In this case, the grinding apparatus is placed at the back of the card and the flats are ground with their faces downwards
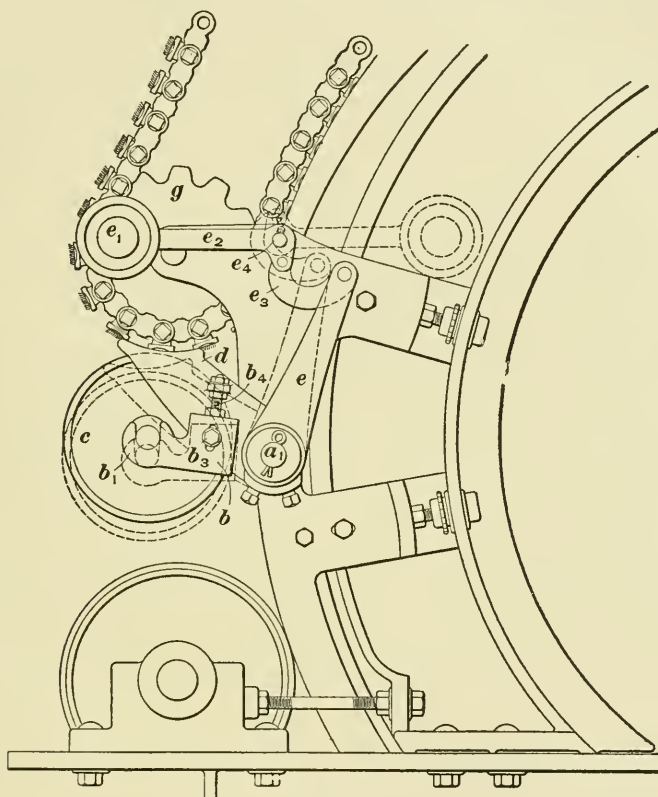
FIG. 10

while in the same relative positions as they occupy when carding. The face of the flat being underneath partly prevents broken wires, pieces of steel, and emery from lodging in the wire and thus being carried around into the carded cotton and incurring the risk of injuring the clothing. The grinding roll c is supported by bearings b_1 that form a

part of the bracket b, which is fastened to the lower part of the former d by means of a setscrew b_3. The bracket that supports the bearings is adjustable and may be altered to bring the grinding roll into its correct position by loosening the setscrew b_3 and turning the adjusting nuts on the setscrew b_4. The upper part of the shoe, or former, d, is so shaped as to give the correct position to the flat, and at its lower end is pivoted on the stud a_1. Pivoted on this same stud and connected with the former, is a lever e that is connected to another lever e_2 by means of the link e_3; the lever e_2 is pivoted at e_4 and carries at its outer end the weight e_1. When the weight is thrown back in the position shown by the full lines in Fig. 10, it raises the former together with the bearings for the grinding roll, causing the former to bear against the end of the flats and thus give each flat the correct position for grinding as it is brought around by the sprocket g. When the grinding apparatus is not in operation, the weight is thrown forwards. By this means the former, together with the bearings for the grinding roll, is lowered, and no part is in contact with the flats. The positions assumed by the different parts when the weight is thrown forwards are shown by the dotted lines in Fig. 10.

The length of time given to grinding the flats varies for the same reasons as those given in connection with grinding the cylinder and doffer, but the intervals between grindings are longer. It is considered sufficient to grind the flats every 4 or 6 weeks. It is advisable, but seldom the practice, for a mill to own a machine for grinding the flats of the revolving-top flat cards. When a mill is in possession of such a machine, it is customary at least once a year to remove the flats from each card and to grind them all to exactly the same gauge, thus insuring that no flat differs from any other in the same card owing to the unequal wear either of the wire or of the ends that rest on the bends.

17. Grinding the Licker.—The licker seldom requires grinding, generally only after an accident has happened to it. When it is necessary to grind the licker, the **solid emery**

or **carborundum wheel** should be used. The licker and wheel are revolved in such a way as to cause the wheel to run against the points of the teeth of the licker. After grinding, the motion of the licker is reversed and the end of a board moistened with oil and sprinkled with powdered emery is pressed against the teeth. By this means the teeth are made smooth. Other methods are sometimes used, such as applying a soft brick or a piece of sandstone to the back of the teeth while the licker is revolving in an opposite direction to its working one.

18. Burnishing.—The card-wire manufacturers supply what is known as a **burnishing brush,** which is now used in some mills. The action of plow grinding or side grinding in the manufacture of wire tends to leave the wire rough at the side, and it is always burnished very carefully before leaving the factory. As it wears down, parts of the wire are reached that have either become rough or were not acted on by the burnishing brush in the manufacturing of the wire. The burnishing brush is therefore used in the mill to burnish the wire on the cylinder, doffer, and flats. It is somewhat the same as the stripping roll, but has absolutely straight wire about $\frac{3}{4}$ inch in length set loosely in the foundation. The brush rests in the stands usually occupied by the grinding roll. It is set into the card wire about $\frac{1}{8}$ inch and makes about 600 revolutions per minute; its outside diameter is 7 inches. It is usually left in operation for a whole day or even longer.

When burnishing the wire on both the cylinder and the doffer it is customary to run them at a very slow speed. This is accomplished in the card under description as follows: A band pulley $14\frac{1}{2}$ inches in diameter having three grooves on its face is compounded with a 20-tooth barrow gear by means of a sleeve. The regular barrow pulley and barrow gear are removed from the barrow stud and the band pulley and gear substituted. The main driving belt runs on the loose pulley, on the edge of which is a **groove 20** inches in diameter. In this groove a band is

placed that drives the band pulley on the barrow stud at about 220 revolutions per minute. The additional grooves in this pulley, by means of bands, drive the burnishing brushes. The speed of the doffer by this method is about 23 revolutions per minute, and as it carries a pulley 11 inches in diameter that drives an 18-inch pulley on the cylinder shaft, the cylinder will rotate at about 14 revolutions per minute. The circumferential speed of the burnishing brushes is about six times that of the cylinder.

SETTING

19. The setting of the different parts of the card requires careful attention and is one of the most important points in the management of the card room. Owing to the wear of the wire in grinding and the wearing of the journals of the shafts carrying the cylinder, doffer, and licker, there is a constant tendency for the wire teeth of the different parts of the card to separate and thus increase the distance between their surfaces. This calls for a readjustment of the various parts, which is known as setting.

The principal places where setting is required are as follows: between the cylinder and the flats, between the licker and the cylinder, and between the doffer and the cylinder. Other places for setting are between the mote knives and the licker, between the feed-plate and the licker, between the cylinder screen and cylinder, between the licker screen and the licker, between the back knife plate and the cylinder, between the front knife plate and the cylinder, between the flat-stripping comb and the flats, and between the doffer comb and the doffer. In order to determine when these parts require setting, it is sometimes necessary to remove certain covers or bonnets and insert gauges, while in other cases the proper time for setting is determined by examining the work delivered by the card, a method requiring an experienced eye. The intervals at which cards are set vary in different mills, but the parts that contain the clothing are usually set directly after grinding, while the time for setting the other parts is

governed largely by the amount of work done by the card
and the stock being used or to be used.

20. Gauges.—The exact setting, or distance between
certain parts, of the card is determined by the use of **gauges;**
two, and in some cases three, kinds are used. The first one
is about 9 inches long and $1\frac{3}{4}$ inches wide and contains four
leaves pivoted together. These leaves are made of thin
sheet steel and are usually $\frac{5}{1000}$, $\frac{7}{1000}$, $\frac{10}{1000}$, and $\frac{12}{1000}$ inch
thick, respectively. The second gauge, which is used exclu-
sively for flat setting, consists of a strip of sheet steel about
$2\frac{1}{2}$ inches long and $1\frac{1}{4}$ inches in width bent at right angles
about $\frac{1}{2}$ inch from one end, with a handle attached to this
end. The other end is the part used for setting and is
usually $\frac{12}{1000}$, $\frac{10}{1000}$, or $\frac{8}{1000}$ inch thick. The third gauge
consists of a quadrant or semicircle mounted on a shaft and
is used for setting the top of the cylinder screen to the cylin-
der and licker, and also in some cases to set the licker screen
to the licker. The curvature of this gauge corresponds to the
curvature of the licker. Card gauges are spoken of in the mill
as being of a certain number, thus a gauge $\frac{7}{1000}$ inch thick
is termed a No. 7 gauge, while a gauge $\frac{10}{1000}$ inch thick is
termed a No. 10 gauge.

Since the leaf and flat gauges are very thin, they are
easily damaged, and in this condition are of little use, pro-
ducing faulty settings; consequently, great care should be
used to prevent the faces becoming dented, bent, or injured
in any way. As the efficiency of the card depends on the
proper settings, it will be seen that any defect in the gauge
will injure the quality of the production of the card. In
many cases poor work results from faulty settings or
poor gauges.

21. Setting the Flats.—In order to make it possible
to set the teeth of the flats the required distance from the
teeth of the cylinder it is necessary that some means be
adopted by which the flats may be raised or lowered as
desired. The manner of accomplishing this will be found to
differ on different makes of cards; one method is shown in

Fig. 11.   In this figure a portion of the cylinder e of the card,
the arch g, and the flats f supported by the flexible bend h are
shown.   It should be understood that there is a flexible bend
similar to h on the other side of the card and that the ends
of the flats rest on this bend in a similar manner to that
shown in Fig. 11.   The bend h is supported by brackets,
which in some cases are composed of two parts h_1, h_2.   In
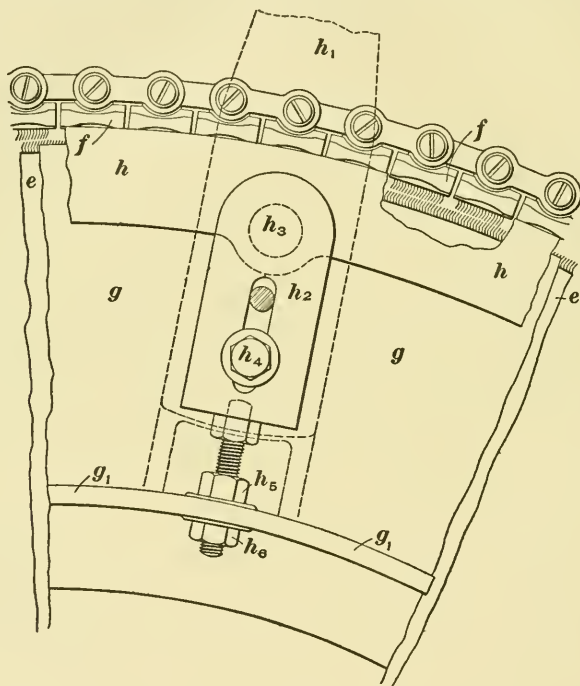
FIG. 11

Fig. 11, the outer portion h_1 is shown in dotted lines.   The
inner portion h_2 is so made that a projecting lug h_3 fits into a
hole in the bend and securely holds it in position.   The
part h_2 is supported by a screw that passes through the
rib g_1 of the arch and carries two set nuts h_5, h_6, one above
and one below the rib.   The bracket is also further held in
position by means of the screw h_4, which passes through a
slot in the bracket and enters the arch of the card.   It is by

raising or lowering the bend h by means of the bracket h_2 that the flats are raised or lowered as desired. There are five of these brackets on each side of the card, and when setting the flats care should be taken that all the brackets are properly adjusted. When setting the flats, the screw h_4 and nut h_6 are loosened and the flats raised or lowered by turning the nut h_5 either down or up, respectively. After the flat has been set in the desired position, the screw h_4 and the nuts h_5, h_6 are firmly secured, thus holding the bracket and bend securely in their proper positions.

22. Another arrangement for setting, or adjusting, the flats is shown in Fig. 12 (a) and (b), of which (a) is a plan view, partly in section, and (b) a sectional elevation. The flats are supported by the flexible bend in the usual manner, but the method of supporting the flexible bend is a radical departure from the one just described, the only resemblance being that both have five setting points on each side of the card. The shell of the cylinder covered with fillet is shown at w, while w_1 represents the flat, which is supported by the flexible conical bend w_2, and this in turn is supported by the rigid conical bend w_3 instead of brackets. The bend w_3 rests on the arch w_4 of the card. It can be seen by referring to the figures that the under surface of the flexible bend is beveled and rests on the beveled surface of the rigid bend; consequently, when the bend w_3 is forced in toward the cylinder the bend w_2 must rise, while on the other hand if w_3 is forced outwards the bend w_2 must fall, thus raising or lowering the flats as may be desired. The bend w_3 is operated by a screw w_5 that projects through this bend into the arch of the card and is held in place by the binding nut w_6. On the inner side of the bend w_3 is a toothed nut w_7 that serves as a binding nut and also as a device for forcing the rigid bend away from the cylinder. On the outer side of the bend is a nut w_8 that serves as an index nut, a binding nut, and also as a device for forcing the rigid bend in toward the cylinder. The toothed nut w_7 is operated by a key w_9 that has a fluted, or toothed, portion to fit the teeth of the nut w_7.

(a)

(b)
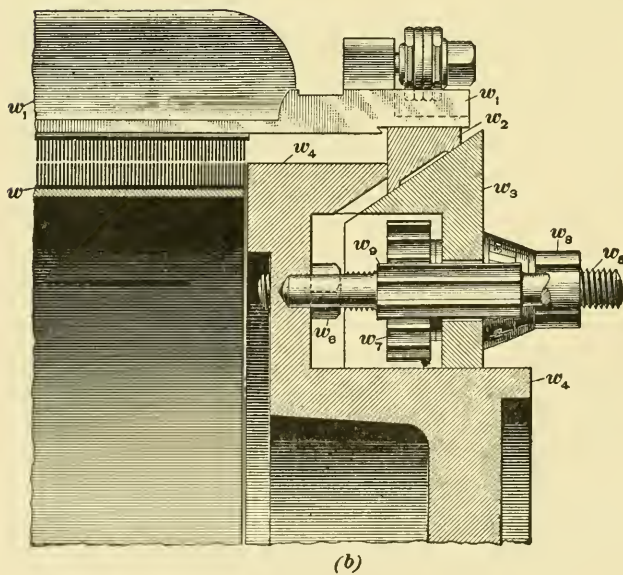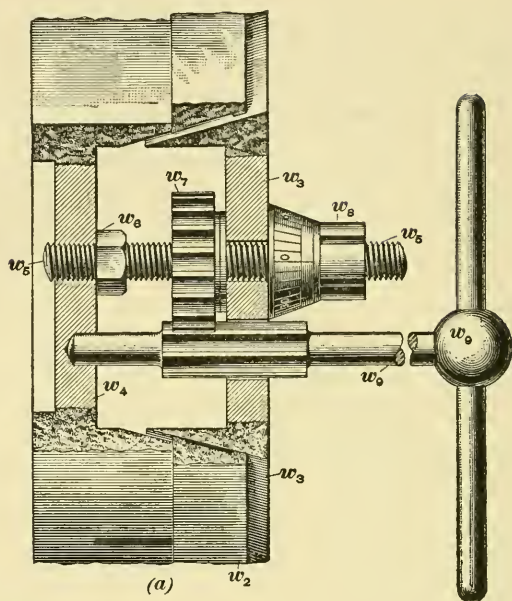
Fig. 12

When it is desired to lower the flats, or set them closer to the cylinder, the key w_9 is inserted in a hole in the rigid bend and engages with the teeth of the nut w_7. The index nut is moved out on the screw and then the toothed nut is tightened by means of the key, thus forcing out the rigid bend and binding it firmly in position. When it is desired to raise the flats, the toothed nut is loosened and the index nut moved in, thus forcing the rigid bend in until the desired position is reached, after which the toothed nut is again tightened. The index nut is provided in order that the person making the adjustment may tell at a glance just how far the flats are moved.

23. The flats are set by means of the flat gauges described, while the card is stopped, and preferably when other machinery in the room is also stopped, so as to prevent any vibration of the floor. In order to provide a blank space in which to insert these gauges, it is necessary to remove certain flats from the chain of flats above the cylinder. Two methods of removing these flats are followed, depending on the method of setting that it is intended to adopt. In those cards constructed with five setting points on each side of the card, it is common to use five flats for setting purposes, a flat being selected that stands almost immediately above each setting point. The flats on each side of the setting flats, as they are called, are removed, making it possible to slip in a gauge on either side of the setting flat; thus, there are ten flats in all removed. A short shaft carries the worm-gear f_{12} and the worm f_{13}, Fig. 2, through which the flats are driven; on this shaft a crank is placed and used to turn the flats while setting. By means of this crank the flats are turned until each of the five setting flats comes directly above a setting point, and they remain in that position until the setting of the flats is completed.

Another method is to remove a flat on each side of one setting flat only, or sometimes two setting flats. This gives but one or two flats that are used for setting purposes, and as there are five setting points on the flexible bend, the chain

of flats must be turned several times in order to bring these
setting flats directly over the places where the gauges are
inserted. Advantages are claimed for each system, but on
the whole there is less work and quicker setting when using
five setting flats.

The side of the flat used for setting purposes is the *heel*,
which is the side nearest the wire on the cylinder, being about
$\frac{3}{100}$ inch nearer than the *toe*. Having brought the setting
flats into the correct position over the setting points, the
gauge is inserted first between the flat and the cylinder above
the central setting point, and the proper adjustment made, as
has been described. In setting a flat it is only possible to
set one end at a time. The end that is being set, however,
should be held firmly in position on its bearings with one
hand while the gauge is moved back and forth across the
card between the flat and the cylinder with the other hand.
Owing to the width of the card it is impossible to move the
gauge the entire length of the flat; consequently, one side is
set temporarily and then the other side is set in a similar
manner, after which the first side set should be tested and
also the second side set to make sure that the flat is in the
proper position. When both ends of the central flat have
been set, the flat at the extreme front of the card is usually
set next, at both ends; then both ends of the flat nearest the
rear of the card are set, and then the two intervening flats.
In setting flats there should be a certain amount of friction,
or resistance, felt when moving the gauge along between the
flat and the cylinder.

The settings mentioned are only temporary settings, and
after the adjustment of the flats the brackets should be
secured and the settings again tested, in order to make sure
that the proper spaces exist between the cylinder and the
flats. The cylinder should now be slowly revolved, the flats
at the same time being moved, and if any rustling sound
is heard it is an indication that the wire surface of the flats is
coming in contact with the wire surface of the cylinder at
some point, in which case the flats should be set farther from
the cylinder at that point.

Fig. 13
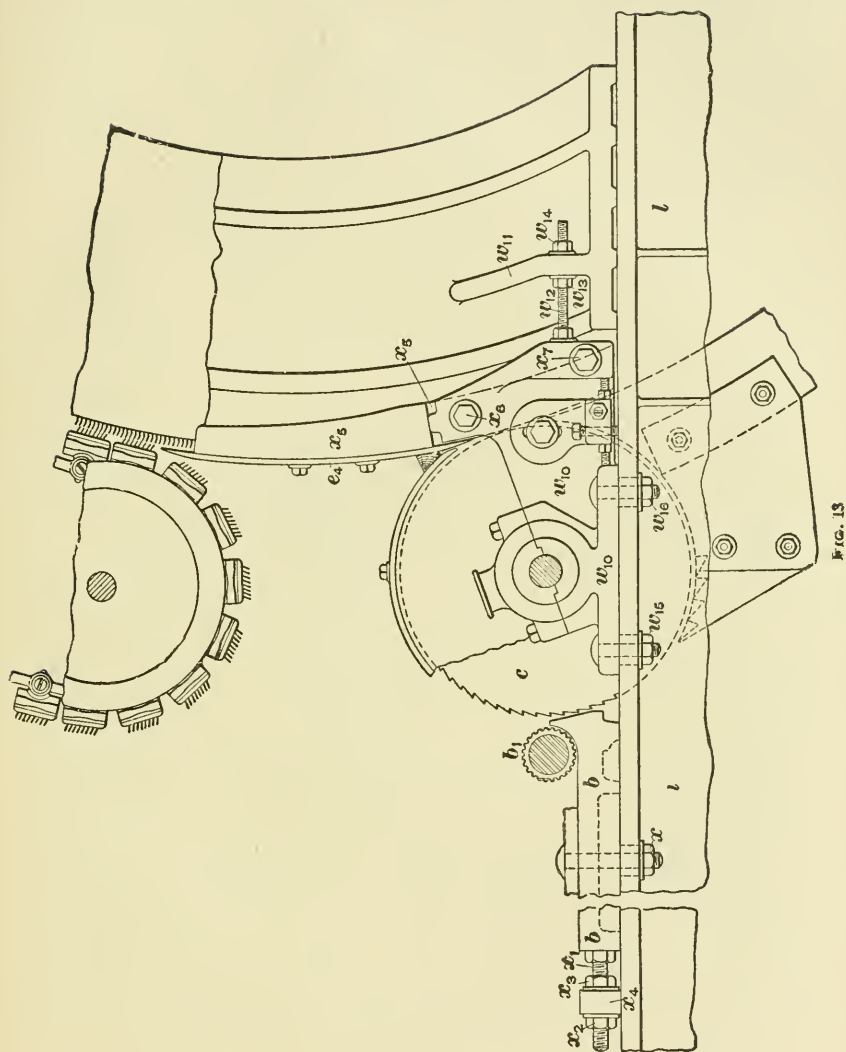
The flats are usually set about $\frac{10}{1000}$ inch from the cylinder at the heel of the flat. The flats at the front of the card should be set the closest to the cylinder, while the space between the flats and the cylinder should gradually increase toward the back. If a No. 10 gauge is used, the flats at the back are set loosely to the gauge; those at the top and center, a little closer; while those at the front are set still closer.

24. Setting the Licker.—The licker is mounted on movable bearings w_{10} resting on and secured to the framework, or base, of the card as shown in Fig. 13. There is a lug w_{11} on the arch of the card, through which an adjusting screw w_{12} for adjusting the licker to the cylinder is passed. By loosening the nuts w_{15}, w_{16}, which securely hold the bearing to the framework, and by operating the adjusting nuts w_{13}, w_{14} on the adjusting screw w_{12}, the licker may be moved nearer to or farther from the cylinder, as desired. The leaf gauge is used for this setting and the licker is generally set to the cylinder with a No. 10 gauge.

25. Setting the Doffer.—The doffer is also mounted in movable bearings w_{17}, Fig. 14, which rest on the framework of the card and are securely fastened to it by the bolts and nuts w_{18}, w_{19}. An adjusting screw w_{20} connects the bearing of the doffer with a lug w_{21} on the arch of the card. When it is desired to set the doffer, the nuts w_{18}, w_{19} are loosened, and the doffer can then be set to the desired position by means of the adjusting screw w_{20} and the nuts w_{22}, w_{23}. The doffer is usually set to the cylinder with a No. 5 or No. 7 leaf gauge by inserting the gauge between the doffer and the cylinder where they are in closest proximity. When a No. 7 gauge is used, the doffer is usually set tight to the gauge. After attaining the proper distance between the doffer and the cylinder, the nuts w_{18}, w_{19} are tightened, as well as the adjusting nuts w_{22}, w_{23}. The position of the doffer with relation to the cylinder is an important matter and should receive careful attention. If the doffer is set too far away from the cylinder, a patchy or cloudy web will result, owing to the doffer not taking
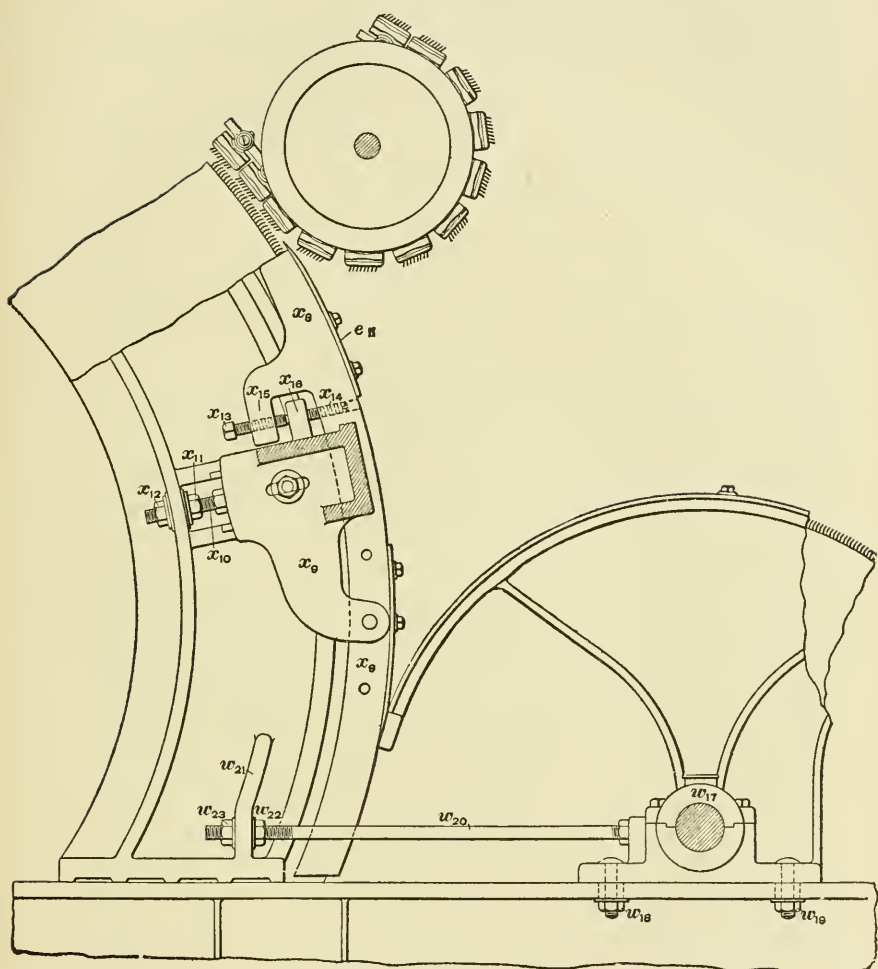
FIG. 14

the fiber from the cylinder regularly and thus allowing the wire of the cylinder to fill up.

The mote knives are carried by two brackets, one at either end, and can be adjusted in regard to the relative distance between their blades and the surface of the licker as described in connection with the construction and operation of the various parts of the card. These knives are set to the licker by means of the leaf gauge and the number of the gauge varies from 12 to 17.

26. Setting the Feed-Plate.—The feed-plate b rests on the frame of the card, as shown in Fig. 13, and is fastened to it by means of the bolts and nut x. When it is desired to set the feed-plate b to the licker c, the nut x is loosened and the plate moved nearer to or farther from it by means of the adjusting screw x_1 and the nuts x_2, x_3. The screw x_1 passes through a lug x_4 on the framework of the card and into the feed-plate. The leaf gauge is also used to make this setting and is inserted between the licker and the face of the feed-plate. The number of the gauge varies from 12 to 20.

27. Setting the Cylinder Screen.—The cylinder screen is made in two sections in the card under description and these sections are fastened together by two staple-shaped bolts, one on each side of the card. These bolts pass through the framework of the card near the floor. Inside the framework of the card on each side is a thin metal arch adjusted so as to be in close proximity to the end of the cylinder. When the screen is in position, it is between, and attached to, these arches, thus forming a casing for the lower portion of the cylinder. The screen is held in position by a number of bolts passing through the side arches of the screen. There are a number of slots in the circular arches of the screen through which the gauge can be inserted in order to obtain the proper distance between the cylinder and the screen.

The nuts on the bolts that hold the screen in position are on the outside of the arches. When it is deemed necessary to set the screens, the doors on the sides of the card are removed to give access to the nuts on the bolts and to allow

a gauge of the proper thickness to be inserted in any of the slots of the screen arch.   The screen is raised or lowered to the proper position as determined by the gauge and the nuts are then tightened, thus holding the screen in position.   The screen is set farther from the cylinder at the front than at any other point, the distance being about .25 inch, while the screen at the center and back is set about .032 inch from the cylinder.   This arrangement prevents the ends of the fibers that have been thrown out by centrifugal force from coming in contact with the front edge of the screen and thus being removed from the cylinder as fly.

28.   Setting the Licker Screen.—As the licker and cylinder screens are very close to each other at their nearest point, and as the front end of the licker screen must be set only a short distance below this point, it is nearly impossible to make an accurate setting with the licker in position.   The best method is to remove the licker and use a quadrant gauge, the curvature of the outside surface of which should correspond exactly to the curvature of the surface of the licker.   This gauge is mounted loosely on a shaft of exactly the same bore as the licker shaft.   The ends of the shaft rest in the licker bearings and the screens are set to the proper distance from the quadrant gauge by sliding the quadrant along the shaft.   The front edge of the licker screen at the point where it is hinged to the cylinder screen is usually set about .011 inch from the licker.   The nose, or portion of the licker screen with which the fibers first come in contact, is set $\frac{1}{32}$ to $\frac{1}{8}$ inch from the teeth of the licker, according to the amount of cleaning action desired at this point and the staple of the cotton being used.   Setting the screen farther from the licker at the nose than at the front allows the fibers to be drawn gradually into a more compact space and presents a more even layer of fibers to the action of the wire on the cylinder.

29.   Setting the Back Knife Plate.—The back knife plate e_4, Fig. 13, extends from the licker cover, or bonnet, upwards to the flats and corresponds in curvature to the

curvature of the cylinder. This plate is fastened to a circular bend x_5 by means of two screws at each end, and the bend is attached to the adjustable bracket of the licker by means of two setscrews x_6, x_7; consequently, when the licker is adjusted the back knife plate is adjusted, or it can be adjusted independently by means of the setscrews x_6, x_7. The plate is set to the cylinder to about a No. 17 leaf gauge at the lower edge and a No. 32 at the upper edge. This allows the fibers to free themselves and stand out a little from the cylinder before coming in contact with the flats.

30. Setting the Front Knife Plate.—The front knife plate e_{11}, Fig. 14, extends from the cylinder door above the doffer to the point where the flats first leave the cylinder. The amount of flat strippings depends to a great extent on the setting of this plate. The plate is fastened to a circular bend x_8 by means of two screws at each end, and can be adjusted by means of the bracket x_9, the adjusting screw x_{10}, and nuts x_{11}, x_{12}; or it can be adjusted to a certain extent by the setscrews x_{13}, x_{14}. The screw x_{13} passes through an arm x_{15} of the circular bend x_8, while both screws x_{13}, x_{14} come in contact with the arm x_{16} of the bracket x_9; thus by loosening one screw and tightening the other the plate can be adjusted. The front knife plate is also set with the leaf gauge, its distance from the cylinder at the lower edge being about .017 inch. The space between the upper edge of the plate and the cylinder depends on the amount of waste that it is desired to remove as flat strippings, but the usual setting is about .032 inch. If the plate is set farther from the cylinder, more and heavier strippings will be made, and if moved too far away, the strips will form one continuous web instead of being connected by merely a few fibers. If the plate is set too close, some of the short fibers and dirt removed from the cotton by the flats will in turn be taken from the flats by the knife and carried around by the cylinder, thus producing bad work.

31. Setting the Stripping Comb.—The flat stripping comb is mounted on two arms, as described in connection

with the construction and operation of the various parts of the card. There is one nut on each side of the comb at each end. The comb is set by adjusting the nuts on the arms when it is at the lowest part of its swing, with its teeth opposite the toe of the flat. Sometimes it will be necessary to try two or three flats before the comb is set in its proper position. The distance between the toe of the flat and the comb is determined with the leaf gauge and is usually about .007 inch; although this setting should be close enough to allow the comb to remove the strippings from the flats, it should not be so close that the comb will strike the wire and damage it.

32. Setting the Brush and Hackle Comb.—The brush for stripping or brushing out the dust, etc., from between the interstices of the flats is set so that the ends of the bristles do not quite reach the foundation of the fillet on the flats. The brush has longer bristles near its ends, in order to brush the ends of the flats where they rest on the flexible bends, so as to keep them clean and preserve the accuracy of the settings.

The hackle comb is set so that the needles, or teeth, of the comb project for a short distance into the bristles of the brush, in order that all the waste may be removed from the brush.

33. Setting the Doffer Comb.—The doffer comb is set in a manner similar to that in which the doffer and licker are set. The comb is mounted on sliding bearings fastened to the framework, or base, of the card by means of bolts. A setting screw is fastened to the bearing of the comb at each side and passes through a lug that is fastened to the framework of the card. When it is desired to set the comb, the nuts on the bolts that attach the bearings to the framework are loosened and the comb drawn nearer to or farther from the doffer by means of the adjusting nuts on the setting screws, as described in connection with the setting of the doffer and feed-plate. When the proper distance is obtained, all the nuts are tightened. The comb is usually set to the

doffer at the point where they are in closest proximity with a No. 7 leaf gauge.

The doffer comb, in addition to being adjustable as to its distance from the doffer, is adjustable as to the position of its stroke, which is changed by altering the relative positions of the comb and the eccentric from which it receives its motion. If the web should follow the doffer instead of being removed by the comb, the position of the stroke should be lowered; while if the web sags between the doffer and the trumpet, as it sometimes does, owing to atmospheric changes, etc., the position of the stroke should be raised.

The settings given are used only as a basis. The settings of the various parts of the card vary according to the stock being used, the quality and kind of finished work, and the opinion and judgment of the superintendent or overseer in charge.

It is sometimes desirable to make a setting for which there is no gauge of the proper thickness at hand. In such cases it is customary to use in combination two or more of the leaves of the leaf gauge; for instance, if it is desired to set the mote knives to the licker with a 17 gauge and no such gauge is available, the 10 and 7 leaves of the leaf gauge can be used together.

MANAGEMENT OF ROOM

34. In the management of cards many points should be watched, but more especially those that have for their objects: (1) the production of good work; (2) turning off as large a production as is consistent with the quality of the work required; (3) economy by avoiding unnecessary waste and keeping down the expenses of wages, power, supplies, etc.; (4) maintaining the machinery in good condition.

35. Quality of Production.—With reference to the first requirement, it may be said that good work is usually judged by examining the web from the front of the doffer. By withdrawing a portion of it as the card is running and

holding it to the light, the foreign matter and also the neps
remaining in the cotton can be observed.   If it is the opinion
of the overseer that from the grade of stock being used and
from the speed of the card such work is not sufficiently good,
the card should be examined to ascertain whether it requires
grinding or setting.   An allowance should be made if the
card is examined just before the time for stripping, as at
that time the card wire is usually so full of dirt that more or
less necessarily passes through, although this is to some
extent an indication that stripping should be performed more
frequently.   In order to test whether wire requires grinding,
or in other words whether it is sufficiently sharp to do its
work, it is customary to rest the fingers of one hand on the
face of the wire when the card is stopped and by drawing
the thumb against the points judge of their sharpness by
the amount of resistance that is felt.   Dull wire allows
the thumb to pass with the least resistance.   Should the wire
show a glistening surface or appear bright on the end of
each point, it may generally be considered dull, although
this is not an infallible test, owing to the direction in which
the light strikes the wire.

The cotton should leave the doffer in a level sheet, free
from cloudiness and having good sides.   The intermittent
clouded effects and flock sides formerly so common are not
met with so frequently in revolving flat cards.   Sometimes
these defects are caused by cotton lodging in some part of
the card, more especially in connection with the screens or at
the point where the cylinder and the doffer meet, until there
is sufficient to be pulled through in one lump by the wire.
Another test is to examine the fly underneath the card and
if it is found to contain an appreciable amount of good fiber,
it indicates that the screens need adjusting.   In case of the
feed-plate, and more especially where two feed-rolls are
used instead of a feed-plate and a feed-roll, plucking some-
times occurs and causes a cloudy effect.   Cotton lapping on
the doffer instead of being stripped off by the comb is trouble-
some, more especially when the rooms are allowed to get
cold during frosty weather.

36. Quantity of Production.—The second point of management is that of obtaining as large a production as possible. This can be obtained by reducing to a minimum the time when the card is stopped for stripping, grinding, or setting, also by the attendants putting on the new lap as soon as the old one has run off and by not allowing the card to remain stopped on account of the end having broken down in front. When these economies of time have had attention, the only other method of increasing the production is to speed up the card, which is usually done by increasing the size of the barrow gear. The increase in the speed of the doffer is in direct proportion to the increase in the size of the gear. There are many cards at work producing 1,000 pounds per week of 60 hours, and the production of a card varies from this down to 200 or 300 pounds per week. A good speed for American cotton when intended for 32s yarn, carding 800 pounds per week, is about $12\frac{1}{2}$ revolutions per minute of a 24-inch doffer for a 60-grain sliver. When carding Egyptian cotton intended for 60s to 90s yarn and carding about 500 pounds in a week of 60 hours, a good speed for a 50-grain sliver is about 10 revolutions per minute. With sea-island cotton intended for yarn finer than 100s, carding 250 to 300 pounds per week and producing a 35-grain sliver, a good speed for the doffer would be about $6\frac{1}{2}$ to 8 revolutions per minute. With a 27-inch doffer the number of revolutions would be proportionally smaller. The maximum average stoppages during a week for stripping, grinding, cleaning, and all sundry repairs around the card ought not to exceed 10 per cent., and with care this might be reduced to $7\frac{1}{2}$ per cent.

37. Economy.—The third point in the management of card rooms is that of economy; this is most important in respect to the amount of waste produced. The largest percentage of waste in any part of a card is in flat strippings and amounts to about $1\frac{1}{2}$ per cent. The next is the amount of fly from beneath the licker and cylinder, amounting to an average of 1 per cent. The cylinder and doffer strippings

together amount to about $\frac{3}{4}$ per cent., making a total loss at the card of about $3\frac{1}{4}$ per cent., or somewhat over $3\frac{1}{2}$ per cent. if the card sweepings are taken into account. No allowance is here made for the unavoidable loss in the weight of the cotton due to its drying in the hot card room. For fine yarns or particular work these figures may be increased, and for coarse yarns and inferior product, decreased.

In order to secure economy in the flat strippings the front plate should be set in such a manner that the flats will not take out any good cotton. When it is set otherwise, the strippings from the flats seem to be connected by a thick film of good cotton that is generally sold together with the strippings as waste. As previously described, this film can be reduced until the strippings cling together by means of a few fibers only. Beyond this point the only method of reducing the amount of flat strips is to lessen the speed at which the flats move, although this is not advisable, as it deteriorates the quality of the work by not removing so much foreign matter from the cotton. The flats will also be connected by a thick strip of cotton if the heel and toe are not preserved in grinding. The principal method of reducing the percentage of the cylinder and doffer strippings is to reduce the number of strippings, which is undesirable unless it is desired to lower the quality of the work. The fly beneath the card can either be increased or decreased according to the style and setting of the screens under the card and the setting of the mote knives. Tests have been made with cards without screens and it is found that they make about ten times as much fly as cards with screens. Both the knives and the triangular bars that form the screens should be so arranged that they will give free passage for any dirt that tends to lodge there and also to allow the ends of the fibers to be combed or brushed over the edges of the knives, but the spaces between the bars of the screens should not be so large as to allow the fibers themselves to be driven through.

38. Proper Care of Machinery.—The fourth point in the management of cards, namely, keeping the machinery in

good condition, necessitates first of all proper oiling.   All
parts of the card that are in contact with swiftly moving
parts, such as the mechanism in the comb box, the cylinder-
shaft bearings, and licker-shaft bearings, should be oiled
twice daily; certain other parts that do not revolve so rapidly,
for instance the doffer, calender-roll shaft, side shaft, coiler,
and all idler pulleys and gears, should be oiled daily; while
once a week, generally Monday morning, every moving
part of the card should be oiled.   Cylinder, licker, and doffer
bearings should be filled with tallow, having a small hole in
the center so that it will allow the oil to run directly on the
shafts and provide a reserve of lubrication that will melt in
case of a hot bearing.   In oiling the bearings of the doffer
and cylinder, care should be taken not to allow the oil
to get on the heads of the cylinder or doffer, since in this
case it is apt to come in contact with and spoil the clothing.
Care should also be used in oiling the traverse grinder that
the oil does not fly on to the clothing.

The cards should be kept free from fly and dust and it is
usually the custom to clean them after the stripping process.
An opportunity should be given at least once a week,
usually on Saturday morning, for the cards to be stopped
2 hours for cleaning purposes, at which time a more thorough
cleaning is given to all parts than can be given while the
cards are running.   About once a month the coiler should be
taken apart and cleaned, the feed-roll taken out and cleaned,
the licker picked free of all foreign substances, and all belts
carefully looked over.   The belts should be cleaned and
dressed as often as it is necessary.   Fly from under the card
is generally removed twice a week, and any cotton or fly
attached to the screens should be picked or brushed off at
the same time.   The roll on which the lap rests should not
be allowed to wear too smooth, but should be painted with
some rough composition, such as paint mixed with sand, that
will give it a rough surface and prevent the slipping of the
lap.   The cylinder and licker screens should be taken out
periodically and cleaned, a good practice being to polish them
well with black lead, which makes them dry and smooth.

The inside faces of the front and back knife plates and the bonnets of the doffer and licker should also be polished with black lead.

After disturbing the settings of a card in any way, the cylinder and licker should be turned around by hand to make sure that there are no parts rubbing. After setting or grinding, and whenever there has been occasion to loosen screws, nuts, or other parts of the card, these parts should all be gone over to make sure that they are tight before starting the card.

39. The speeds of the different parts of the machine are taken by a **speed indicator.** The doffer, however, has so few revolutions per minute that its speed can be ascertained by watching a point on its circumference and counting the number of revolutions it makes.

There should be only sufficient draft between the lap roll and feed-roll, the doffer and the bottom calender roll, the bottom calender roll and the calender roll in the coiler to take up any slack that may occur between these parts. Any excessive draft causes the sliver to be unevenly drawn, thus making thick and thin places in the yarn.

COTTON CARDS

CARD-ROOM DEVELOPMENTS

STRIPPING

DEVELOPMENT OF VACUUM STRIPPING

1. Card Waste.—Cotton cards, especially those parts of cards covered with card clothing, such as cylinders and doffers, are constantly collecting waste material. Some unavoidable card waste is in the form of fly, or short cotton fiber, that defiles the air and settles on various parts of the cards, from which it may be easily removed; but the major part of the card waste is of a more bothersome nature and interferes with the working efficiency of a cotton card. Wastes to be included under this heading may be listed as follows: cylinder and doffer strips, flat strips, or, in fact, all waste and foreign matter that becomes embedded in the card clothing. Waste of this character generally consists of short fiber that must be removed from the interstices of the card clothing periodically to insure the production of sliver of maximum quality.

2. Early Stripping Equipment.—The removal of waste from card clothing is known as *stripping*. Several different methods of card stripping have been used extensively, and among these may be mentioned hand stripping, roll stripping, and vacuum stripping.

Hand stripping was first employed on the early cards but is no longer used. This method consists of using a hand card made by tacking a piece of card clothing to a rectangular-shaped board. The card is drawn over the surface of the card cylinder by the

operative and the wire teeth on the card comb the embedded fibers from the clothing of the cylinder.

Roll stripping was introduced to replace hand stripping because of the tremendous loss of production incurred by the earlier method. A stripping roll usually consists of a wooden roll slightly longer than the width of the card. Steel shafts, or gudgeons, project from both ends to support the roll, which is driven by a grooved pulley keyed to one of the shafts. The stripping roll is covered with a card clothing which is similar to that used on the card cylinder except that it has much longer teeth and they are not set so close together. Brackets bolted to the framework of the card act as bearings and support the stripping roll in such a position that the wire on it comes in contact with the wire of the card clothing. One set of brackets holds the roll in contact with the cylinder, while another set holds it in contact with the doffer. A band passes around the small grooved pulley on the stripping-roll shaft and the large idler pulley on the main cylinder shaft drives the stripping roll. The idler pulley is driven by the main driving belt, being run partly on the main pulley and partly on the idler pulley, thus causing the stripping roll to turn. The rapidly revolving stripping roll will then strip the embedded fibers from the card cylinder.

Vacuum stripping represents a recent and improved method of card stripping. This type of stripper utilizes the principles of vacuum, or reduced air pressure, in creating a suction to remove the embedded waste from the card clothing. Vacuum stripping reduces the time and the labor required in stripping operations, and removes practically all the dust and fly so prevalent during stripping, thus maintaining more healthful working conditions for the operatives.

3. **Types of Vacuum Strippers.**—Vacuum strippers are usually divided into two classes; namely, portable units and permanent units. Essentially, the portable unit consists of an ordinary stripping roll covered with a metal hood. A flexible tube is attached to the hood and runs to a small vacuum pump or exhaust fan which exhausts into some form of container for separating the cotton waste from the air. This portable vacuum

stripping unit is used in practically the same manner as an ordinary stripping roll, that is, a stripping roll is still used but it is covered by a metal hood. Most of the lint and dust raised by the stripping roll is drawn by vacuum through the flexible tube to a container provided for this purpose, where the lint and dust are removed from the air. This system, while using a portable unit, possesses all the advantages of a vacuum stripping system, with a small initial expenditure. The burnishing action of the stripping roll on the card wire is still retained and, in the estimation of some mill men, is beneficial to the card wire.

A permanent-unit type of vacuum stripper generally consists of some form of stripping device built into the card, and this mechanism is connected to a central station, or waste room, by means of pipes, or tubes. The central station houses some type of vacuum unit, either in the form of a vacuum pump or an exhaust fan, and a condenser, or some other unit to separate the waste and dust from the air.

Several forms of permanent strippers are available, although their construction and principles of operation may vary slightly. For example, one form of vacuum stripper works on the principle of a stripping roll for removing the embedded fibers from the card cylinder, but utilizes vacuum to keep the stripping roll clean. Another system of vacuum stripping consists of using vacuum only as the stripping medium. A small hollow hand-shaped casting carries two nozzles. One of the nozzles is supported in close proximity to the doffer wire and the other in the same relative position to the card-cylinder wire. The casting is caused to traverse across the card-wire surfaces while the cylinders are rotating. A flexible tube attached to the casting makes connection with the central vacuum unit, which draws, or sucks, the embedded fibers from the card clothing.

<center>SACO-LOWELL VACUUM STRIPPER</center>

4. Construction.—One form of permanent vacuum stripper, developed by Saco-Lowell, is shown in Fig. 1. Essentially, this stripping unit is composed of two main parts; namely, a casing, or housing, *a* and a small stripping roll, or brush. The casing is built around the stripping roll in such a manner that they

act as a unit. That is, the roll is free to rotate within the casing, but, as the bearings of the stripping roll are built into the casing *a*, the casing and the stripping roll must be moved together when it is desired to change the position of the roll. Special
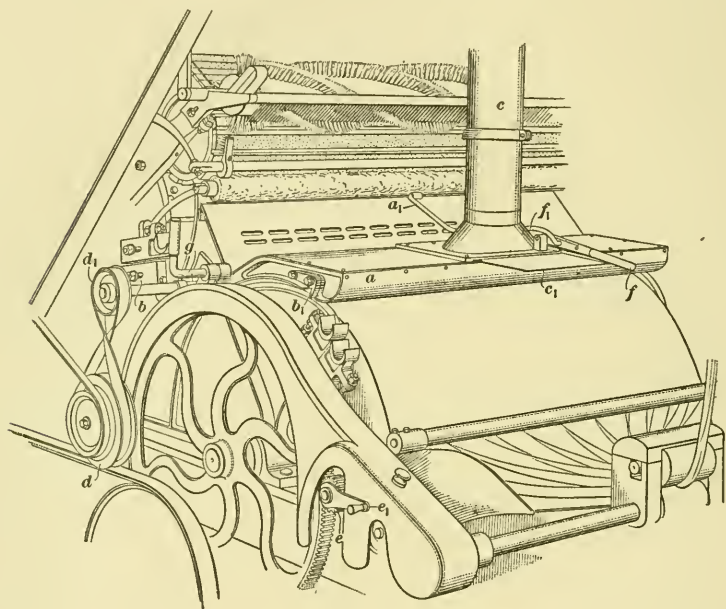
Fig. 1

brackets *b* are fastened to each side of the card framework to help support the unit. The bearings holding the stripping roll and incorporated in the casing *a* are held in the bracket *b* and have a limited horizontal motion. The portion of the casing over the doffer is supported by adjustable projections b_1 that are bolted to the casing and rest in notches on the card frame. Therefore, the stripping unit may be moved either forward or backward a limited distance in the bracket *b*. The rear part of the stripper casing, supported by the projections b_1, will likewise move, the projections sliding in the notches on the card frame. The casing *a* contains a chamber with one end connected to the vacuum pipe *c*, while the other end of the chamber tapers to a long narrow nozzle having an opening about 1 inch high

next to the stripping roll and extending the width of the stripping roll. A thin plate, or door, c_1 is embodied in the lower part of the pipe c for the purpose of opening or closing the vacuum connections.

When this form of vacuum stripper is installed on a card, several alterations must be made. The front knife plate, stripping plate, or percentage plate, as it is sometimes called, and the lower front plate, protecting the cylinder between the flats and the doffer must be altered to accommodate a removable front cylinder plate built into the stripping unit. This plate is connected to the thin plate c_1 in the pipe line c by a suitable mechanical linkage so that, when the plate c_1 closes the vacuum connections and the stripper is not in operation, the front cylinder plate is closed to prevent stray air currents from interfering with the carding action. But, when the vacuum connections are opened, the front cylinder plate will be removed, exposing the card clothing.

The stripping roll is driven from the main driving pulleys. A small circular band fits into the groove on the outside of the 20-inch idler pulley and into a groove on the compound pulley d. A flat, crossed belt runs between this pulley, held on a stud attached to the framework, and the pulley d_1 on the end of the stripping roll.

Two forms of installation are available with this type of stripper. One form has all the vacuum pipes which go to each card connected to overhead pipes that run the full length of the card room. Such an installation is shown in Fig. 1. The pipes running the length of the room are connected to one main vacuum pipe, which is connected to a condenser and a fan. The condenser, similar to those used in trunk lines in the opening and picking rooms, separates the cotton waste from the air, while the fan exhausts this air into the dust chamber, allowing the dust to settle. Another system that is sometimes used is to have all vacuum pipes and lines run beneath the card-room floor. This provides a neat, compact installation that eliminates all overhead pipes, and consequently the usual cleaning of lint and fly from such card-room pipes. With such an arrangement, the main vacuum line is run along the ceiling of the room beneath

the cards, and pipes branch from it to the individual cards. These pipes are run through the card-room floor at the doffer end, usually between the comb and the calender rolls, and are about as high as these rolls. An easily removable air-tight cap covers the mouth of each pipe. Whenever the card is to be stripped, a short piece of flexible tubing is snapped into place at the vacuum pipe line to connect the casing of the stripping unit with it.

5. Operation.—Previous to stripping, the supply of cotton entering the card should be stopped and all cotton in the card run out. Usually, this is accomplished by disengaging the side shaft, thus stopping the feed rolls, whereas disengaging the gear c, Fig. 1, by means of the handle c_1, will stop the calender rolls and the coiler. As a result, whatever cotton remains in
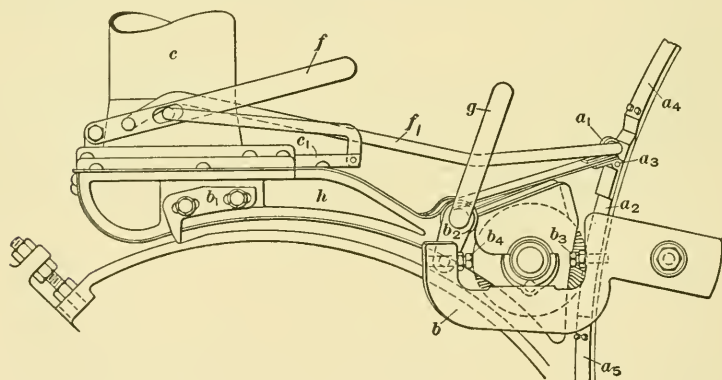
Fig. 2

process in the card will be combed from the doffer to the floor in veil, or web, form. The veil is usually returned to the opening or picker room to be reworked, thus effecting a saving in raw-stock costs. When practically all the cotton has been cleared from the card, a small circular belt is placed around the 20-inch loose pulley and the compound pulley d. The main driving belt is moved to such a position that it is running partly on the loose and partly on the tight pulley, thus causing the compound pulley and the stripping roll to revolve rapidly and the card cylinder to turn slowly.

The lever f is connected to the thin plate c_1 in the vacuum
line and to the rod f_1, which is attached to the upper part of the
stripper casing at the point a_1. Normally, when the stripper is
not in operation, the lever f is in a vertical position. As the
lever is pulled backward to the position shown in Fig. 1, pre-
vious to stripping, the rod f_1 will be drawn backward, and con-
sequently it pulls the upper part of the casing with it, thus caus-
ing it to rotate around the rod g about which it is hinged.
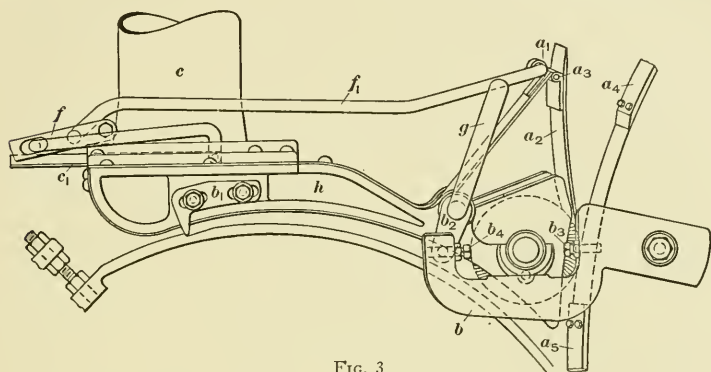
FIG. 3

The front cylinder plate a_2, Fig. 2, is hinged to the top of the
stripper casing at point a_3 in such a manner that it rests in its
normal position against the front and lower knife plates a_4 and
a_5 when the lever is in a vertical position as shown in this illus-
tration. The lever, when in a horizontal position, as in Fig. 3,
will raise the cylinder plate upward and out, leaving the cylinder
wire exposed. At the same time, the lever f also moves the
thin plate c_1 outward, thus opening the vacuum connections
between the vacuum pipe c and the nozzle h.

The rod g, also shown in Fig. 2, extends the full width of the
stripping unit and passes through the holes that have been
drilled in projections on either side of the casing. An arm b_2,
Fig. 3, is connected to the rod g at each side of the casing, each
arm pivoting about a pin projecting from the bracket b. Thus,
when the rod g, which is bent at one end to serve as a handle,
is pushed forward toward the card cylinder, the stripping roll
will come in contact with the teeth of the card cylinder, the

casing, also, being moved forward. The teeth of the rapidly revolving stripping roll as they mesh with those of the card cylinder will pull the matted and embedded fibers from the clothing of the slowly revolving cylinder. As the stripping roll continues to revolve, the waste material removed by the roll passes by the nozzle and a strong suction, concentrated over a small area by the nozzle, draws the matted cotton from the stripping roll. The strippings are carried through the nozzle h, up the vacuum pipe c, and through the main line to the central station, where they are separated from the air currents at the condenser. The main cylinder is usually allowed to revolve a full revolution or more with the stripping roll in contact with it before the lever g is pulled backward to bring the roll in contact with the doffer. The teeth of the stripping roll will mesh with those of the doffer and the strippings will be removed in practically the same manner. The lever g is returned to its central position after the doffer has been completely stripped, and the circular driving belt is removed from the loose pulley. The lever f is moved to its vertical position, closing the cylinder plate and vacuum connections to the pipe c.

Adjustments are provided on the bracket b for regulating the distance that the teeth of the stripping roll enter those of the cylinder and the doffer. By moving the setscrew b_3 in or out, the distance that the stripping roll enters the wire of the cylinder may be regulated. The setscrew b_4 controls the distance the roll-wire penetrates into the doffer clothing. In this manner, serious injury to the card clothing is prevented during the stripping operations.

6. **Advantages.**—The permanent form of vacuum stripper described offers several advantages not obtainable with roll stripping. First, superior stripping is obtained because of the partial elimination of the human element in stripping operations. In some instances when a pressing schedule of stripping operations is to be carried out, the operative may roll-strip one card more thoroughly than another. This means that all the waste and matted fibers are not removed from the card clothing, and consequently a poor-quality card sliver would be produced.

With this form of vacuum stripper it is necessary that the operative merely move a lever to bring the stripping roll in contact with the card clothing, thus eliminating, to a great extent, much of the variable human element from stripping.

Another feature of this system is the saving in labor it affords. Ordinarily, with roll stripping, two men are required to carry out this operation. The vacuum system not only makes it possible for one operative to carry out the work of stripping, but also enables the operative to strip efficiently a greater number of cards.

Healthful card-room working conditions are promoted through the use of vacuum stripping. Practically all of the lint and fine dust which would be thrown off by the regular stripping roll is absorbed by a vacuum system and carried to the central station. The waste matter is not only prevented from defiling the air and providing unhealthy working conditions for the operatives, but is prevented from settling on the stock in process and thus producing an inferior card sliver.

Some mill men claim that the burnishing action of the long stripping wire against the card clothing, as obtained in this system of vacuum stripping, is beneficial, as it tends to smooth and remove the burrs on the end of the card wire. Others claim that this action is not beneficial but harmful, because, in their estimation, it is a harsh action that tends to loosen the wire in the card clothing.

COOK-GOLDSMITH VACUUM STRIPPER

7. Construction.—The vacuum stripper shown in Fig. 4 and produced by Abington represents a distinct departure from previous stripping systems. In this case, the use of a stripping roll in any form is dispensed with and the action of a strong vacuum or suction is substituted. This system may be described as a multipurpose unit, because, while it is used for card stripping, it may be employed as a waste-collection system to be used in all sections of the mill. Also, it finds use as a vacuum cleaning unit.

Special brackets *a*, Fig. 4, are attached to the card framework at the doffer to support the vacuum stripping unit. A long

shell, or hollow barrel, a_1 is held in these brackets with the shaft a_2 revolving inside the shell. The shaft is constructed in such a manner as to impart to the casting b, holding the nozzles and sliding on the shell, a traverse motion extending across the width of the card. The nozzle b_1, about $2\frac{1}{2}$ to 3 inches wide,
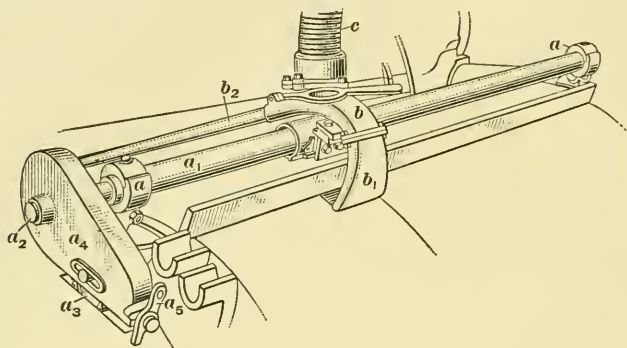
FIG. 4

is attached to the casting b and held in close proximity to the doffer wire. The other nozzle b_2, about 1 inch to $1\frac{1}{2}$ inches wide, slides in a slot in the cylinder plate or door at the front of the cylinder. A flexible tube c connects the casting holding the nozzles with the vacuum pipes leading to the central station.

The nozzles receive their traversing motion from the shaft a_2, Fig. 4, which is driven by a gear secured to it and that meshes with the gear a_3 held within a gear casing, or guard, a_4. The gear a_3 is, in turn, driven by the large gear on the doffer shaft. A section of the gear casing over the large gear on the doffer shaft is cut away in such a manner as to allow the idler gear a_3 to mesh with it. The two gears held within the gear casing are in constant mesh with each other, but at the same time are held in such a manner as to permit the casing, and consequently one of the gears, to revolve around the shaft a_2. Attached to the gear casing a_4 is a lever a_5. When this lever is raised vertically, it lifts one end of the casing with it, thus preventing the idler gear a_3 from meshing with the large gear on the doffer shaft.

8. Operation.—The supply of stock entering the card is usually stopped previous to stripping. Vacuum connections are

FIG. 5

made between the stripper and the pipe line. The lever a_5 is
moved to mesh the driving gears of the stripping mechanism
with the large gear on the doffer shaft, thus setting the unit in
operation. The nozzles will slowly traverse across the width
of the card as the cylinder and doffer revolve at their normal
velocity. The stripping mechanism is so geared and adjusted
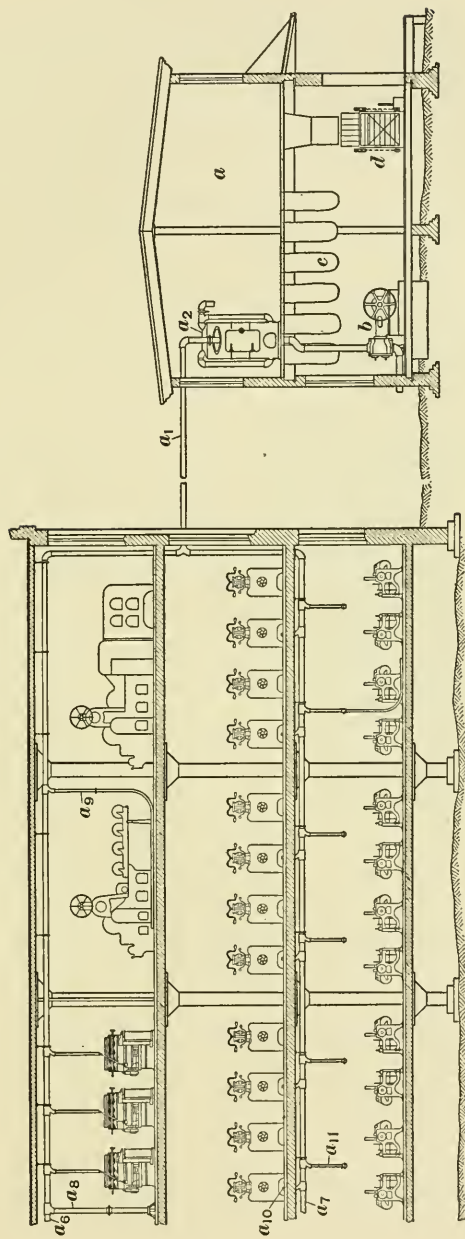that as the nozzles move slowly across the width of the cylinders,
a section of card clothing that has not been stripped will always
come under the nozzles. It is desirable that the nozzle slightly
overlap the section already stripped, to insure efficient removal
of all waste. The strong air suction, concentrated over a small
area by the nozzles, draws out practically all the embedded
fibers, fly, and dirt that have accumulated in the card clothing.
The central station in this system of vacuum stripping makes
use of a receiver, or separating chamber, in place of a condenser.
The receiving chamber not only separates from the air the waste
material removed during stripping, but also acts as a storage
receptacle. A vacuum pump operated in conjunction with it
provides the high degree of vacuum, or suction, required.

9. Waste-Collection System.—The Cook-Goldsmith vacuum
stripping system is often referred to as a triple vacuum system
because of the three purposes for which it may be used. Essen-
tially, this system may be used for card stripping, for waste
collection, and for cleaning machinery, or for a combination of
these functions. A mill equipped to obtain full advantage of
these features is shown in Fig. 5. The waste house a is usually
a separate building, although this is not always necessary. The
conducting pipe a_1 connects the waste house with the mill. Gen-
erally, the waste house is not placed at too great a distance from
the mill because the efficiency of the system tends to decrease
if waste has to be drawn a distance of much over 1,000 feet.
The waste drawn through the conducting pipe is deposited in
the receiver a_2, the air being drawn through the receiver and to
the vacuum pump b, from whence it is exhausted into the
atmosphere.

The receiver a_2 is shown in detail in Fig. 6. The waste mate-
rial enters the unit at the top and is deposited in the large cham-

beı a_3. This chamber will hold almost a bale of waste; thus frequent cleaning is unnecessary. The large door a_4 enables the operative to remove quickly, and with little difficulty, all of the cotton waste collected, thus reducing the cleaning period to a minimum. Grates are placed in the chamber at about the door level to allow the dirt and dust sucked along with the cotton waste to be separated from it and drop into the dirt chamber below. The small door a_5 offers a means of cleaning the dirt chamber. Usually, bins are built along the walls close to the receiver to hold the various grades of collected waste until sufficient quanti- ties are obtained to permit baling. Sometimes openings in the floor are provided for holding the waste bags c, Fig. 5. In this case, waste is packed into the bags to facili- tate handling. Another open- ing in the floor allows waste to be fed to the baling press d. In case the waste is sold, it is generally baled, as trans- portation costs are lower when it is in a compact form.
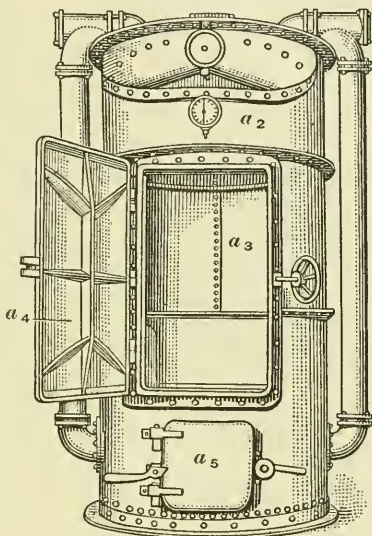
FIG. 6

A suction pipe line a_6 runs along the top of the card and picker rooms, while another pipe line a_7 runs along the ceiling of the weave room, both lines being connected to the conducting pipe a_1. Flexible tubes attached to the stripping units on the cards are connected to the pipe line a_6 and a collection station a_8, also, is usually located in the card room. All waste matter, such as flat strips and the like that are not removed by the vacuum stripper, is collected at this point and several times during the day the waste is dispatched through the collection system to the waste receiver. A collection station is, in reality, a large vacuum pipe extending to the floor and having a suit-

able attachment to permit piles of loose waste to be sucked through the system to the receiver. This procedure provides an excellent method of handling almost all waste matter in the card room.

The pipe line a_9, going to the picker room, is also connected to the main pipe line. Motes and other waste material from beneath the beaters in the picker may be sucked out by means of this line. The short pipe lines a_{10}, extending through the floor of the spinning room, are connected to the pipe line a_7. These short pipes are fitted with detachable, air-tight, covers. Whenever the spinning frames are to be cleaned, a flexible tube is snapped on the end of the pipe a_{10} and a nozzle on the end of this tube will suck up practically all lint and dirt, whether it is on the machine or on the floor. Much time and effort are saved by employing this system of cleaning. For instance, the laborious work of picking the rolls and saddles, the bobbin gears, and other parts of spinning frames and fly frames of lint is greatly simplified through the use of this vacuum system.

Vacuum offers a decisive advantage over compressed air for cleaning, because it removes all lint and fly to a central receiving station, whereas compressed air simply blows the fly around, allowing it to settle on machinery in a short time. Lint collecting on or around bearings sometimes causes the bearings to overheat, and fly collecting on the gears often results in excessive wear. Also, when the compressed-air system is used, the possibility of fly collecting on the material being processed and causing bad work always exists.

The vacuum system of cleaning may be applied to the weaving room by connecting flexible tubes to the pipes a_{11} that extend from the pipe line a_7. Generally, the looms may be cleaned while they are in operation, to save time. Practically all waste material, including hard twisted waste, may be successfully removed by this process of cleaning.

The maintenance of a definite schedule of stripping operations permits waste of certain classes to be sucked to the central receiving unit without the mixing of waste of different qualities. The segregation of waste made at various stages of processing of cotton allows a mill, especially if it produces large quantities

of waste, to obtain full resale value from it in the open market. Otherwise, the mixing of waste of a better quality with lower grades will greatly reduce its market value. In some cases, mills find it advantageous to return certain wastes to be mixed and processed with the raw stock.

10. Features.—The triple vacuum system of card stripping has for one of its main advantages the combining of three functions within one mechanical unit, namely, those of card stripping, waste disposal, and vacuum cleaning. The combining of these three uses into one unit permits it to be operated continuously, thus providing an adequate return on the original investment.

An advantage of using only vacuum as a means of stripping a card is that the card clothing is not injured. Practically all particles of dirt, dust, and fiber are removed from the card clothing, provided the proper degree of vacuum is maintained, whereas it is claimed that, when a stripping roll is used, only the waste matter about the knee of the card wire, or the point to which the stripping wire reaches, is removed. It is further claimed that the remaining matter not removed by the stripping roll finds its way into the card sliver. Where the triple vacuum system of stripping is used, quantities of black dirt and similar matter are found in the dirt chamber of the receiver. This black dirt, if it were not removed from the card clothing, would find its way into the card sliver with detrimental results.

When this system of vacuum stripping is used, it is possible for one man to strip efficiently about 250 cards three times a day. This represents a great saving in time over the former methods of card stripping. Also, with other methods, the frequent shifting of the driving belt from the tight pulley to the loose pulley and vice versa, as required during stripping, tends to cause much strain and wear on the belt. But with this stripping system, it is not necessary to stop the card to strip it; therefore the card not only remains in continuous production, but also much wear and tear on the driving belt is eliminated.

The triple vacuum system, when used for waste collection, offers a quick, clean, and efficient method of handling waste. Practically all waste may be sucked to the central station for separation into various grades for resale or reuse. In this manner, the use of hand trucks or other equipment for waste collection is eliminated. The vacuum system may also be used for cleaning and to take the place of the usual blowing of lint from the various manufacturing machines. Therefore, instead of blowing the fly and lint to other parts of the room, where
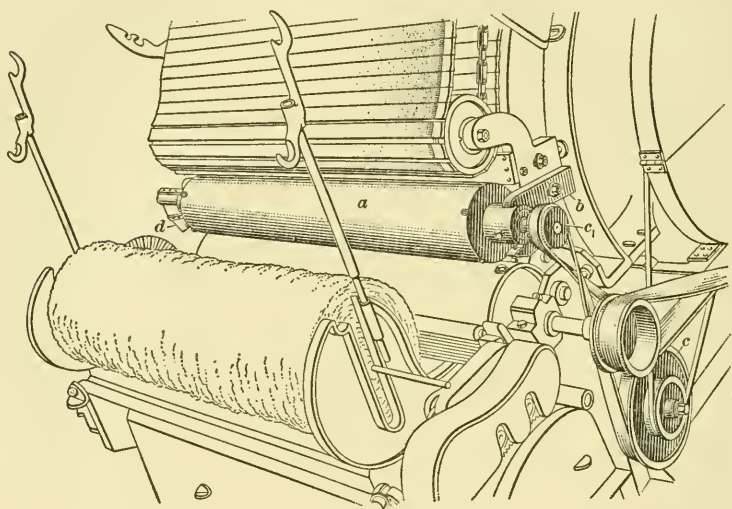
Fig. 7

it must be swept up later, the system carries the lint directly to the central station. Also, the vacuum system may be operated for cleaning while the machinery is in operation, without producing detrimental effects on the stock being processed.

CONTINUOUS CARD STRIPPING

11. Benefits From Continuous Operation.—The continuous card stripper, developed by Saco-Lowell, is shown in Fig. 7 as it appears when installed on a card. This unit represents an innovation in card stripping because of its automatic nature; that is, the stripper is in operation continually while the card

is running, thus making it unnecessary to stop the card for stripping operations. Previously, when a card was stripped with the regular stripping roll, the card production had to be stopped while the stripping roll was operated by two men. A card working on medium-grade cotton would require this operation two or three times a day. This meant that there were several periods throughout the day when the card was nonproductive. Also, a loss in stock was incurred, because a part of the sliver produced after stripping was light or under weight and had to be discarded as waste.

The continuous card stripper reduces card stoppage and loss of production caused by stripping, because it is necessary to strip the doffer only about twice a week with a stripping roll, and the cylinder only previous to card grinding. Also, it is not always necessary to stop the card while the doffer is being stripped, although it is highly desirable to do so. Stopping the card prevents the stripping roll from throwing waste matter into the card sliver, as is liable to happen if card production is not stopped.

Essentially, the continuous stripper consists of a set of needles, or pins, projecting from a roll. The roll is set in such a manner as to cause the needles to extend into and between the card wire of the cylinder. A rotary motion is given to the roll and a definite speed ratio is maintained between the roll and the card cylinder so the needles will turn against the back of the card wire. The brush-like action of the needles against the back of the card wire tends to raise the fibers embedded in the wire, thus giving the card flats an opportunity to work on these fibers. By continually raising the fibers that are embedded in the card cylinder, normal carding action is obtained and the necessity of stripping is obviated.

12. Description.—The continuous stripping unit *a*, Fig. 7, is mounted at the feed, or back, end of the card. The brackets *b*, one attached to each arch of the card, hold the stripper in place. Power to drive the unit is obtained from the double pulley *c*, which in turn is driven from the 20-inch main driving pulley.

The stripping mechanism is built around a $1\frac{1}{2}$-inch square steel shaft a_1, Fig. 8. The shaft has its cylindrical ends supported in roller bearings to permit free rotation of the shaft and accurate setting of the stripper to the card cylinder. Several sections of needle bars a_2 are attached to the square steel shaft.
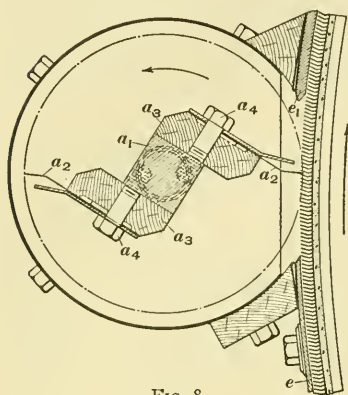
Fig. 8

The needle bars are generally mounted on a wooden block a_3, which extends the length of the steel shaft, and a bolt a_4 passes through the block, securely holding it to the shaft. This method of assembly furnishes the strong but resilient mounting required by the needle bars. One section of the needle bars is shown in Fig. 9. Usually, the long, thin, flexible needles are mounted in groups of four. A special grade of steel is required to furnish the desired strength to the needle and yet retain the degree of elasticity demanded of it. A group of three needle bars is usually bolted to each side of the shaft in such a manner as to stagger the needles; that is, the needle bars are so placed on the shaft a_1 that the needles on one side of the shaft are not in line but come between those on the other side.
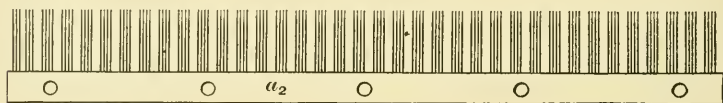
Fig. 9

A traversing mechanism d, Fig. 7, consisting of a worm and gear, is used to give the stripping mechanism a horizontal traversing motion of about $\frac{1}{4}$ inch. The traverse enables the needles to act on the full width of the card and, at the same time, varies the point of contact between the needles and the cylinder wire so the stripping needles will pass between all of the wires. In this manner, efficient raising of practically all

the embedded fibers in the card clothing will take place because the needles of the stripper pass through practically every square inch of clothing. A polished steel casing encircles and protects the entire stripping mechanism and obviates the possibility of injury to the operative. It also prevents fly from being thrown by the stripper and acts as a guard by keeping the air currents from interfering with the proper carding action.

The continuous card stripper is generally driven by passing a round belt $\frac{7}{16}$ inch in diameter around the 20-inch grooved main pulley. The round belt drives a combination flat and grooved pulley c, Fig. 7. This combination pulley is mounted on an adjustable stud to allow the belt tension to be changed. A flat cross-belt runs from the pulley c to the small pulley c_1 on the end of the stripper shaft. Pulley diameters are of such dimensions as to provide a fixed ratio of speed between the card cylinder and the stripper, the latter having the greater surface speed. Generally, the ratio maintained is between 1.00 and 1.25.

13. Installation.—Several slight changes must be made on a cotton card before a continuous card stripper may be attached. Generally, a number of flats, usually about six, must be discarded and the chain shortened to make room for the stripping unit at the back of the card above the licker. A new back knife plate is required, being made in two sections.

The back knife plate between the licker housing, cylinder, and the flats is removed and a new lower back knife plate e, Fig. 8, is bolted in place above the licker housing, a clearance of about .058 inch being maintained between the cylinder wire and the plate. A narrow top knife plate e_1 is bolted in place under the flats, a clearance of about .058 inch being left at the lower edge of the plate and the cylinder wire and a clearance of about .034 inch between the plate and the cylinder wire at its top. The stripper casing is bolted in place between the two plates in such a manner that the needles a_2 are in contact with the card wire for a distance of about $1\frac{1}{4}$ inches. Usually, this setting will prevent the needles from extending too great a distance into the card wire and injuring the foundation of

the card clothing. Care must be taken in installing the stripper, because it must always be installed to rotate in a direction opposite to that of the card cylinder and at a greater surface speed. Also, the needle points must work against the back of the cylinder wire.

14. Advantages.—The continuous card stripper offers several advantages not readily found in other forms of stripping units. Undoubtedly, its greatest advantage lies in the fact that its action is continuous. By constantly raising all of the cotton fibers to the surface of the card clothing, fibers are prevented from becoming embedded in the clothing and thus the necessity of stripping is obviated. One of the greatest difficulties encountered in carding is the controlling of the gradual variation in weight of the sliver caused by the loading down of the card after stripping. When a card is started after the ordinary stripping operation has taken place, some of the fibers will become embedded in the card clothing, therefore a lighter card sliver will be produced. A smaller number of fibers become embedded as the card continues to operate, but, as the card clothing gradually becomes filled with embedded fibers, many of the fibers which would have formerly been embedded now must pass forward into the sliver; consequently, the weight of the card sliver gradually increases. Generally about 70 yards of sliver must be produced after stripping before the normal sliver weight is reached; then beyond this point there is a slight tendency for the sliver to run heavy. The constant raising of all embedded fibers by the continuous stripper insures a constant weight of sliver and consequently eliminates all sliver-weight variation caused by a card loading down with embedded fibers.

Generally, a slight increase in the production of sliver, and in its quality, results from the use of continuous stripping. Production increase is usually obtained by the reduction in card stoppage afforded by continuous stripping, while sliver quality is improved by constantly keeping the stock fed to the card on the surface of the card clothing, thus giving the flats an opportunity to work on all the stock. Therefore, aside from

the production of a slightly better quality of carded cotton, many of the long fibers, formerly embedded in the card wire, are allowed to pass into the card sliver. Cylinder strips are eliminated with continuous stripping. Usually, this waste will amount to about .4 per cent of the total production and, in some cases, as high as 1 per cent. To a certain extent, this also allows many of the longer fibers in these strippings to go into the sliver and, at the same time, affords a substantial saving in cotton.

Ordinarily, a card not equipped with a continuous stripping unit will require stripping about two or three times a day and, in some cases, every 2 hours when low-grade cotton is run. Several minutes are required to complete this operation. Over a period of time the production lost because of stripping will amount to considerable poundage. Therefore, the use of continuous stripping results in not only increased production, but also in enabling the operatives that formerly took care of the stripping to engage in productive work. Also, practically all of the fly and dust thrown off by the stripping roll is eliminated and the card room is a much healthier place for the operatives to work in.

In some cases, savings in power have been reported through the use of continuous stripping. Generally, less power is required to operate a card immediately after roll stripping, but the power-consumption chart shows a gradual rise as the card loads down with matted and embedded fibers. The power required for operating a card equipped with a continuous-stripping unit shows only a slight variation. As a result, a small saving in power is claimed for the continuous stripper.

<div align="center">FANCY ROLLS</div>

15. The purpose of a fancy roll is to facilitate carding cotton waste, or low-grade stock. Usually, when short-staple cotton or waste material is run on a card, it has a tendency to load-down, or fill the card clothing with short matted fibers. Ordinarily, when carding is carried out under these conditions, the cotton has a tendency to roll and form small round balls of tangled fiber. These small balls, or neps, as they are often

called, are practically impossible to remove from the sliver and
will cause much trouble in future processing operations. While
it may be possible to eliminate many of the neps in the sliver
produced through closer card settings, it is not always advisable
to do so, because of the low quality of the product for which
the sliver may be intended. Therefore, frequent card stripping
is necessary. A slight loss in production is always entailed
by the frequent intervals at which the cards must be stripped.
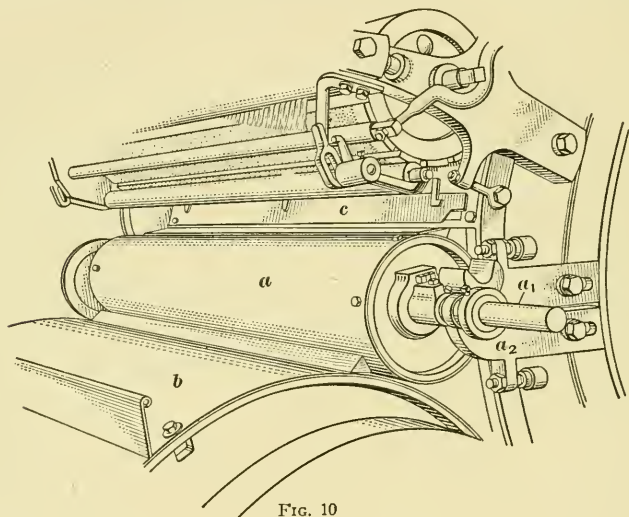
Fig. 10

The introduction of a fancy roll, it has been found, tends to
stop the formation of neps and to reduce greatly the number
of times a card must be stripped. In reality, a fancy roll oper-
ates on the same principle as a continuous card stripper, that
is, it continually raises most of the cotton fibers to the surface
of the card clothing.

A fancy roll, as used on many cards working on low-grade
stock, is shown in Fig. 10. A casing a completely encases the
fancy roll, which consists of a wooden roll covered with long
straight wire like that used on a burnishing brush. The roll
shafts a_1 are held in the card grinding brackets a_2 that are bolted
to the arch of the card. The bearings are constructed in such
a manner as to allow the entire fancy roll to be removed so

card stripping and grinding may be carried on unobstructed. When the fancy roll is in place, however, triangular wooden strips are placed between the fancy casing a and the doffer casing b, and also between the fancy casing and the knife plate c for the purpose of steadying the unit and preventing fly and lint from settling between the casings. The roll is driven like the continuous stripper from the grooved driving pulley and a suitable speed ratio is maintained. Care should be taken to have the teeth of the fancy roll working against the back of the cylinder wire and at a greater surface speed, to raise the embedded fibers to the surface of the card wire. If these conditions are not met, the purpose of the fancy roll is defeated.

When the stock consists of short, trashy, low-quality cottons, fancy rolls are generally used. Their use on the better grades of work is seldom found because, in some cases, short fiber and trash may be thrown by the fancy roll. If this material should find its way into the card sliver, the quality of the resulting sliver would be greatly impaired. When used on low-grade work, the fancy roll tends to prevent the formation of neps and also lessens the frequency of stripping by reducing the amount of short fiber embedded in the card clothing.

CARD CLOTHING

STRAIGHT WIRE

16. Many varied types of card wire have been developed and some of these have been introduced to the carding trade for the purpose of finding a suitable card clothing. Probably the present-day type of card wire with the knee is the most successful, although other forms of card wire have been used with good results under special conditions.

A form of straight wire has been recently introduced for card clothing. This wire consists of a straight, strong, wire tooth that closely resembles the wire used in card clothing with the exception that the knee, or bend, as found in card wire, is absent. Generally, this type of wire finds its greatest use on cards working on low-grade cotton and on those producing a coarse card sliver. The principal advantage derived from the

use of this wire is that the card does not require frequent stripping and grinding as would be expected when running low-grade stock. Instead, the stripping usually required every few hours is now required only once every week or two, it is claimed.

METALLIC WIRE

17. Another form of card wire recently introduced is a metallic wire or, as it is commonly called, a metallic card clothing. This wire closely resembles that used to cover the licker, and has the same sharp serrated teeth, resembling those of a saw. The wire comes in long strips or rolls, and grooves are required in the cylinders to hold the wire in place, it being wound spirally around them.

It is claimed that the use of this metallic wire greatly reduces the periods between stripping and grinding; therefore, less labor is required for stripping and less waste is removed because of this operation. It is stated that a card equipped with this clothing can generally run for 1 to 2 weeks without stripping, whereas a card clothed with regular wire would require stripping every few hours. Because of the strong serrated teeth, a card using this clothing lends itself to excellent work on low-grade cottons, especially where a coarse sliver is being produced. The strength of the teeth greatly reduces the possibility of damage to the card wire which is prevalent when carding low-grade stock.

INDIVIDUAL MOTOR DRIVES

INTRODUCTION

18. Advantages of Individual Motor Drives Over Belt Drives.—The use of individual motor drives, that is, the use of a motor connected directly or indirectly to a machine for the purpose of furnishing power solely to that machine, is increasing in popularity in the textile industry. Undoubtedly, the wide usage of this method of driving is due to its numerous inherent advantages.

Generally, an individual motor drive eliminates the use of a large number of leather or rubber belts as a medium of trans-

mitting power. The elimination of driving belts removes, to a certain extent, the possibility of injury to the operative. In some instances, his hand or parts of his clothing may become caught in a rapidly moving belt, and invariably a badly mangled hand or other serious bodily injury results. Besides the great potential danger to the operative that is always present when open driving belts are used, the flickering shadows caused by the rapidly moving belts interrupting the light are also detrimental to the operative's eyes. Then, too, the fire hazard is greatly increased by the fanning action of these rapidly moving belts. Another serious disadvantage of belt drives is the loss in production resulting from stoppage of the main driving motor, either through breakage or defective wiring. Under such conditions, all cards dependent on the main driving motor are stopped.

19. Application to Cards.—The application of individual motor drives to cotton cards is a recent innovation. Undoubtedly, the slow development of a satisfactory drive greatly retarded its use in this field until recently. Numerous obstacles, peculiar to cotton cards and not found in most textile machinery, had to be surmounted. For example, a card is usually run at a constant speed of about 165 revolutions per minute. After a considerable period of operation, it becomes necessary to sharpen the points of the card wire. This grinding operation is carried on by reversing the direction of rotation of the cylinder and running a grinding roll against the card wire. To reverse the cylinder rotation, either the direction of rotation of the motor has to be reversed, or a set of gears or some other method of reversing has to be employed. Individual motors capable of being reversed are expensive and gearing and other arrangements are usually bulky and unsatisfactory. Another problem presented by the card is that a very high starting torque is required at starting; that is, about three times as much power is required to start the card as is used to keep it in continual operation. An electric motor, to work under such conditions, would have to be well designed to prevent overheating while operating under overload conditions. Also, provisions

must be made to cool the motor efficiently without having lint and fly from the cards collecting on its working parts.

Numerous forms of individual motor drives have been used, with varying degrees of success, for powering cards. A direct drive, that is, one having the motor shaft connected directly to the card cylinder shaft without the use of intermediate gears, would not be practicable with cards or most types of textile machinery. The low speed required by the cylinder, usually about 165 revolutions per minute, in addition to the tremendous power required for starting, would necessitate the use of a motor of abnormal size. It has been found that gears, link or chain belts, and V-belts form efficient methods of transmitting power from individual motors to cotton cards, and to practically all textile processing machinery.

The power requirements of an individual cotton card are varied. The type of stock being carded, the size of sliver produced, the size of the card, and the equipment used, such as continuous card strippers, fancy rolls, and other auxiliary equipment, all tend to change the power required. Regardless of the type of equipment used or the stock carded, it may be safely said that an individual motor-driven card generally requires about $1\frac{1}{2}$ to 2 horsepower, whereas a card driven from a line shaft requires a smaller amount of power.

<div align="center">GEAR DRIVE</div>

20. Description.—A form of gear drive used successfully for powering cotton cards is shown in Fig. 11. All overhead belts, pulleys, and shafting are eliminated when this form of drive is used. The card room is much cleaner and lighter and lint is not blown around by the rapidly moving belting. Often this lint, when blown around, settles into the veil of fibers leaving the doffer and produces inferior work.

A special motor to meet the requirements of high starting torque and sudden overloads demanded by cards has been developed. The motor a, Fig. 11, is generally supported by a special bracket, or stand, attached to the card framework. A large gear b, attached to the main cylinder shaft, is driven by a small pinion gear on the motor shaft. A guard c protects the gears.

In cases where vacuum stripping and continuous stripping are employed, provisions are not generally made for using a stripping roll. When the cards depend solely on a stripping roll for the necessary stripping operations, the driving motor is usually equipped with a long shaft; that is, the motor shaft is extended in such a manner that a grooved pulley or sheave may be keyed to the shaft, opposite the pinion gear. A rope is passed around this pulley and that on the stripping roll.

Fig. 11

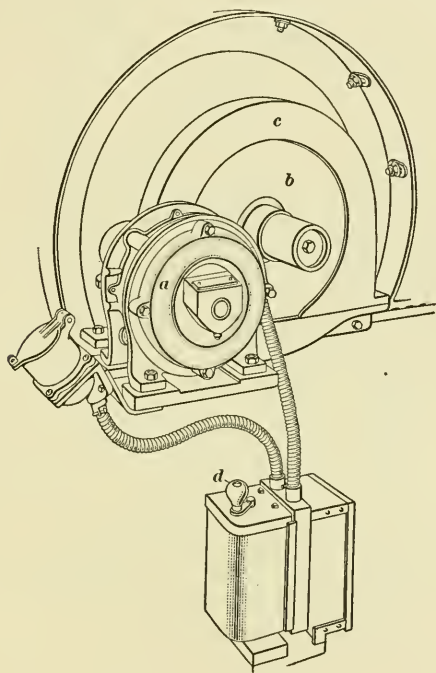Generally, for starting the motor, a switch is used that is equipped with some form of thermal overload protection to prevent damage to the motor when loads are applied too suddenly. In some cases, a hand-operated switch *d* is used, and in other instances a magnetic push-button switch is employed. When it is necessary to reverse the rotation of the card cylinder for grinding, the most convenient method of accomplishing this

is by means of a reversing switch. The reversing connections are usually enclosed and interlocked in the main switch case in such a manner as to prevent the card from being reversed until it has stopped. Thus, the operator cannot reverse the card while it is still rotating, and serious damage to the driving motor and to the card is prevented.

21. Advantages.—Practically all individual card drives possess about the same advantages, most of which are not obtainable when belting and shafting are used for power transmission. Generally, a slight increase in production is obtained through the use of individual drives, regardless of the type employed. This is attributed to the more positive drive they offer because much of the belt slippage found in shafting is eliminated. The use of shafting allows a large amount of the lint and fly in the card room to be fanned by the rapidly traveling belts and, consequently, much of this material will settle either on the card or in the stock being processed. This will not only result in poor work, but the fly constantly defiling the air creates unhealthful working conditions for the operatives. Frequently, card clothing and stock in process are injured by oil either dripping from overhead shafting or being thrown by it. In other cases, serious injury to the operative has resulted when replacing an open driving belt with a closed one, as is necessary for reversing the direction of rotation of the card during grinding operations. This is a dangerous operation to perform because the line shafting is not usually stopped. Practically all of the foregoing disadvantages and hazards are obviated when individual motor drives are used.

Greater flexibility of operation is obtained with individual motor drives. For example, if trouble with the main driving motor in a group drive occurs, every card operating from that shaft is stopped. In case of trouble with individual drives, only that card having trouble would be stopped; therefore, the production of a group of cards is not materially reduced. In other cases it may be desirable to operate only one or two cards, or a small group of cards, but, with the group, drive shafting for all cards must be operated whether they are productive or

not. The electric current required by a number of small motors, in such a case, is much less than that required by a large main driving motor.

22. Another form of drive sometimes used on cards is known as a link-belt, or chain, drive. Such a drive is shown in Fig. 12. This form of drive is often called the silent link-
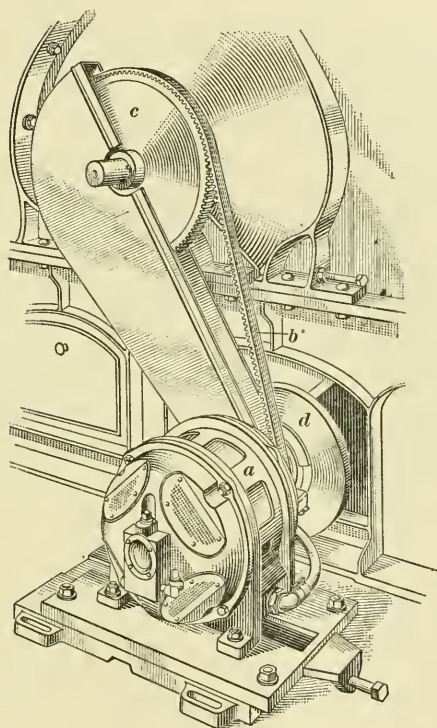

Fig. 12

belt type, because it is much quieter in operation than a gear drive. A link belt is composed of a large number of short metal links or bars having toothlike projections at each end. The links are pinned together, the number of links on one pin determining the width of the belt, and in such a manner as to form a long, continuous but flexible belt. The belt is run

around wheels, and each toothlike projection on the belt extends down between the wheel teeth to give a positive driving action, but owing to its construction the belt is practically silent in operation.

Various arrangements of link belt drives may be used; for example, a typical installation is shown in Fig. 12. The motor a is mounted on a special stand that may be supported on the card framework, whereas in other cases, the motor is mounted on an adjustable base fastened to the floor. When the floor mounting is employed, an adjustable base is used because the distance between the motor and card cylinder must be varied to allow removal or adjustment of the link belt. One type of link-belt drive, as shown in Fig. 12, has the link belt b running from a pinion wheel to a large driven wheel c on the end of the card shaft. The pinion wheel is carried as a part of the clutch d, which is attached to the motor shaft. Thus it is possible for the card to be stopped without stopping the motor. A guard is always placed around the link belt and driving wheels to protect the operative from serious injury and to prevent the throwing of oil by the driving mechanism. Many installations do not employ a clutch but have the link belt running direct from the motor to the card. In such instances it is necessary to stop the motor when the card is stopped, and in most cases a motor of slightly greater power is required.

V-BELT DRIVES

23. Sometimes **V** belts are used in individual motor drives for powering cards, although they find their greatest use in connection with other textile processing machinery.

A multiple **V**-belt drive, as commonly used for driving textile machinery, consists of two pulleys, or sheaves, one on the driving and one on the driven shaft. Each pulley has **V**-shaped grooves cut in its face, the number varying according to the amount of power transmitted, the overload placed on the drive by starting strains, and other conditions under which the drive might operate. A number of **V**-shaped bands run in the grooves and connect the two pulleys. Generally, these bands are built around a core of strong cotton cord containing a number of

ply yarns or cords running lengthwise of the band. A special rubber coating is built up around the core until the desired **V**-shape is obtained.

Undoubtedly, the greatest advantage offered by this type of drive is its resiliency. The **V**-shaped driving bands have the ability to absorb sudden shocks, many of which are caused by sudden starting loads and, consequently, they provide a steady, smooth flow of power.

BALL BEARINGS

24. In some instances, it has been found advisable to replace the ordinary bronze cylinder bearings of a card with ball or roller bearings because of the advantages that usually result. When new cards are ordered, many are specified to be equipped with ball bearings. The use of these bearings is not always limited to the main cylinder of a card, but often extends to the doffer and the licker.

Some of the advantages derived through the use of ball bearings in cards are as follows: (1) Various card settings may be made more accurately and these settings maintained over a longer period of time without added attention. This is made possible through the elimination of excessive vibration and abnormal wear. (2) Wear on the bearings and cylinder shaft is reduced to a minimum because of the reduction in friction and the superior methods of lubricating these bearings. (3) Oil leaks and stained cotton as well as damaged card clothing caused by oil dropping on it, are practically eliminated by the use of ball bearings. These bearings are sealed in the pedestal box supporting the cylinder and are usually lubricated with grease or heavy oil. Sealing in the bearings in this manner greatly reduces the amount of lubrication and the attention required to insure normal care-free operation of the cylinder bearings. (4) Savings in power required to operate the card are possible because of reduced running friction. Also, there is less wear and tear on the driving equipment because, in many instances, the starting friction and the running friction in a ball-bearing equipped card are practically the same, whereas starting friction in a card not equipped with ball bearings greatly exceeds the running friction.

CARD-ROOM MANAGEMENT

WASTE TESTS

25. Value of Waste Tests.—A waste test, that is, the careful observance and weighing of all waste matter and all sliver produced by a card, as well as the amount of stock fed, should be conducted at periodic intervals by the card-room management. Such a test is important because it offers a check on the quality of the carding, and it also gives an indication of the mechanical condition of the card. Also, records are obtained which are helpful for cost computation.

Generally, three different kinds of waste are made by cards. First, *motes* are removed from the stock by the mote knives and are therefore found in the chamber under these knives. Motes usually consist of heavy leaf, sticks, dirt, and practically all heavy foreign matter not removed in the opening and cleaning processes. This type of waste matter has very little market value because it generally consists of trash and contains very little cotton fiber. Fly consists of short fibers and light dust that have dropped or been thrown from the main cylinder and the doffer. Some of this waste comes from under the screen that extends around the lower part of the cylinder. Fly is generally included with the mote waste in tests because only a small amount is usually found. Ordinarily, the combined waste matter will amount to about 1 to 3 per cent, depending on the grade of the stock carded and the mechanical condition of the card. Fly is a term also applied to the short pieces of cotton or lint that defile the air and settle on various parts of the machinery and on the floor of the card room. All material of this nature found around a card during a waste test is generally recorded as waste under the heading of *Floor Sweepings.*

Second, *cylinder* and *doffer strips* are obtained by stripping the cylinder and doffer of embedded cotton fibers. Usually this waste consists of short matted fibers and dust and dirt. About .5 to 1.5 per cent of the stock represents the amount of waste of this character to be expected. No specific percentage can be stated for this waste because it usually varies,

depending on the grade of cotton used, the condition of the card clothing, and the frequency of the stripping operations. Fiber of this character generally has very little market value because of its shortness.

Third, *flat strips* consist of the short fibers, and occasionally some fairly long fibers, carded from the stock by the revolving flats. Generally, the amount of this material is about 2.5 to 3.5 per cent of the stock, depending on the grade of stock run, the card settings, and the condition of the card clothing and flats. Flat strips have a fair market value, although in some cases mills working on low-grade work, and some mills on medium grades, return the flat strips to be reworked and used with new cotton.

26. Conducting Waste Test.—A special record sheet similar to the accompanying Card Waste Test form is used while conducting a waste test. Divisions or spaces are made on this record sheet for tabulating pertinent data. Under the heading *Waste Collected,* space is provided for recording in pounds, ounces, and percentages the amount of waste stripped from the cylinder and the doffer, the flat strips, the motes and fly, and the floor sweepings, or that fly and material found in the vicinity of the card. Space is also provided for the weight of the lap and that weight of the lap remaining after the test. The final lap weight should, of course, include the lap rod because it is weighed with the lap before starting. In case the entire lap is consumed during the test, the weight of the lap rod would constitute this reading. In another column the weight of the sliver produced is recorded. This is generally found by subtracting the weight of the sliver can from the gross weight of the sliver. The sliver waste, that is, the sliver discarded at the beginning of the test as being too light, is listed and also the total card waste. The invisible gain or loss, a calculated value, is computed, both in weight and in percentage.

The term *invisible gain* signifies a gain or an increase in the weight of the cotton processed or, in other words, the card delivers a greater weight of cotton than is fed to it. The term *invisible loss* is contrary to invisible gain, that is, more cotton

CARD WASTE TEST

_____ MANUFACTURING CO.

Lot No. _____   Test No._____

Grade   _____   Date_____ 19___

Staple   _____   Time Run _____

Waste Collected			
Waste	Pounds	Ounces	Per Cent
Cylinder and Doffer Strips			
Flat Strips			
Motes and Fly			
Floor Sweepings			
Total Card Waste			

	Wt. of Sliver _____
Wt. of Lap—Start _____	Wt. of Sliver Waste _____
Wt. of Lap—Finish _____	Card Waste _____
Cotton Fed _____	Cotton Delivered _____

Check Balance

Cotton Fed _____

Invisible Gain _____

    Cotton Delivered   _____

    Invisible Loss   _____

Total   _____   _____

Percentage Invisible Loss or Gain _____

Data

Size of Lap   _____

Size of Sliver   _____

Main Cylinder R.P.M. _____

Licker R.P.M.   _____   Moisture Test

Doffer R.P.M.   _____   Wt. When Start _____

Flats—inches per min. _____   Wt. When Finish _____

Draft gear   _____   Loss or Gain _____

Barrow Gear   _____   Percentage _____

Remarks : _____

_____

Test Made By_____Approved By_____

is fed into the card than can be accounted for at delivery. A moisture test is usually run simultaneously with the waste test for checking the invisible losses or gains. Several spaces are left for recording the weight of a sliver used for the moisture test at its start and finish. Additional space on the sheet is used for listing the lot number, the grade, and the staple of the cotton used for the waste test, as well as such information as cylinder speeds, draft gear sizes, and the like.

27. A card must be cleaned thoroughly before the actual waste-test run is begun. The main card cylinder and the doffer are first stripped and this waste matter is discarded. The revolving flats are allowed to make one complete revolution to be certain all waste matter in them has been removed. While the flats are being stripped, all waste under the mote knives and other sections of the card is removed. The card is brushed to remove all lint and fly that might have settled on it, and the floor around the card is swept for a considerable distance. All waste matter thus far collected is discarded, because it is not pertinent to the waste test.

The lap is weighed, placed in the card, and the card started. The lap weight is recorded in its proper division on the waste-test sheet. The card sliver produced should be running at its normal size after a few minutes of card operation. The sliver of normal size is threaded through the coiler head and the card allowed to operate for a predetermined time or until the lap has about run out. The undersize sliver first produced and not run through the coiler head is weighed and recorded on the test sheet under the heading of sliver waste along with whatever web waste is made after the sliver has been broken off at the completion of the test. After the desired amount of cotton has been processed, the lap is broken off and the weight of the remaining lap section entered under weight of lap finish. By subtracting this weight from the gross lap weight, the net weight of the cotton fed into the card is obtained.

The card is allowed to run out, the cylinder and doffer are stripped, and all card waste is removed and its weight recorded in the proper columns, the motes and fly being weighed

together. After the flats have revolved once to insure strip-
ping of all of them, this waste material is weighed and recorded.
The card is brushed and the floor in the vicinity of it swept to
collect all fly and lint that has been thrown off by the card.

The sum of the weight of all card waste, the sliver waste, and
the card sliver produced will give the weight of the cotton fed.
Under normal conditions the weight of the cotton fed and the
weight of the cotton delivered should equal each other, although
in many cases these two figures will not coincide. When the
amount of cotton delivered by the card exceeds the amount fed,
an invisible gain results. A waste test may be run under cer-
tain conditions and a small invisible gain may be shown without
the test being considered inaccurate. Usually, a rough check
known as a moisture test is made during the waste test to deter-
mine if an invisible gain or an invisible loss is permissible.

28. A moisture test is desirable because the invisible gain
or loss found in the card test may be checked by it. While sev-
eral types of moisture tests may be made, the following test is
accurate for most purposes and does not require the use of
expensive equipment. Generally, a sample of the lap of cotton
being processed and weighing about 500 grains is placed close
to the card on which the test run is being made. Weighings
are made of the sample throughout the card-waste test to
determine whether the sample has increased or decreased in
weight by absorbing or giving off water vapor to the atmosphere.
An increase in sample weight would indicate that an increase
in humidity or moisture in the air has taken place. This same
increase will, naturally, also take place in the cotton in the card
being tested. Therefore the weight of the cotton delivered will
exceed that of the cotton fed, but this weight increase does not
actually change the volume or the amount of stock processed
and is therefore not accountable; it is called an invisible gain.
A decrease in the weight of the sample during the moisture test
would likewise indicate that there is a reduction in humidity, or
that the air is absorbing some of the moisture that is in the cot-
ton. In this case, the check balance of the waste-test sheet
should show an invisible loss.

A rough check may be made to determine whether the invisible gain or loss occuring is due to moisture or to errors made in the test. Generally, the gain or loss in the stock expressed in percentage and the gain or loss in the moisture-test sample expressed in percentage should approximately equal each other. A large variation in percentages would tend to show that errors have been introduced in the card-waste test.

29. Evaluating Waste Test.—Waste tests are usually run on cards for comparative purposes. For example, a mill has two different samples of cotton, both of the same grade but from different sections of the country. It is assumed that practically all characteristics of the cotton are alike but the mill would like to know which cotton would be the more economical to buy. A card-waste test could be run and the sample showing the lower percentage of waste would normally be the better grade to buy. In other instances, a waste test might show that certain cards are in need of adjustments or repairs.

Comparative waste tests are often run on various grades of cotton to determine which grade is the most economical to process. While the initial cost of a lower-grade cotton may be less than that of a superior grade, the final cost of the processed cotton for the better grade may be less. This is generally shown by the waste test. Usually, a much greater amount of waste will be obtained from the low-grade cotton and therefore more frequent cleaning of the card will be necessary. The increased amount of waste and cleaning will increase the frequency of card grinding and result in an increase in production cost. When the final cost computations are made, in many cases it will be found more economical to use a higher grade of cotton and, in spite of the increased initial cost of the cotton, the final cost per pound processed may be less.

30. Card efficiencies may be checked by waste tests. These tests may be conducted on a number of cards operating on the same grade of cotton. In this case, the cards showing the greatest amounts of waste should be checked for incorrect settings and adjustments. An expert carder can usually deter-

mine the mechanical condition of his card by inspecting the waste produced. In many instances, the carder may, by glancing at the card waste, know if his card needs regrinding. The efficiency of a card can also be determined by glancing at the flat strips. The strips on an efficient card usually have sufficient long fiber in them to allow them just to cling, or hang, together. If a greater percentage of long fibers is present, an excessive amount of good fiber will be removed by the flats, whereas if not enough fiber is present to hold the strips together, insufficient cotton is being removed by the flats.

<div align="center">SLIVER TESTER</div>

31. Sliver Testing.—One important phase of card-room management is the production of a uniform and even sliver of cotton. A constant check on the uniformity and evenness of the sliver is usually maintained by weighing 1-yard lengths of the sliver at frequent intervals.

About ten 1-yard lengths of sliver are cut, they are weighed individually, and the average of the ten weighings is found. The deviation, that is, the variation between each weighing and the average weight, is usually determined to give an indication of sliver evenness. This indication of evenness will, of course, indicate only the variation in each 1-yard length. It is possible, therefore, for variations to occur in lesser lengths, such as 1-inch lengths of sliver. For example, a 1-yard length of sliver may show great variations in 1-inch lengths, but these variations may occur in such an order as to neutralize themselves in a 1-yard length; that is, the sum of the variations above the average weight and the sum of the variations below the average weight may equal each other so that, in this case, the 1-yard weight would appear to have practically no variation, while actually, inch for inch, a tremendous variation exists.

It would be highly impracticable for weighings to be taken in smaller units of length than a yard because of the vast increase in time required and the large number of errors introduced by weighings of small magnitude. But the checking of small units of length in a sliver is of great importance for the production of a sliver of maximum uniformity. Therefore, to

accomplish this work efficiently and accurately, a sliver testing instrument known as a *sliver tester* was developed.

32. Description.—The sliver tester, developed by Saco-Lowell, is shown in Fig. 13. Essentially, this machine consists of two rolls that slowly draw between them the card sliver to
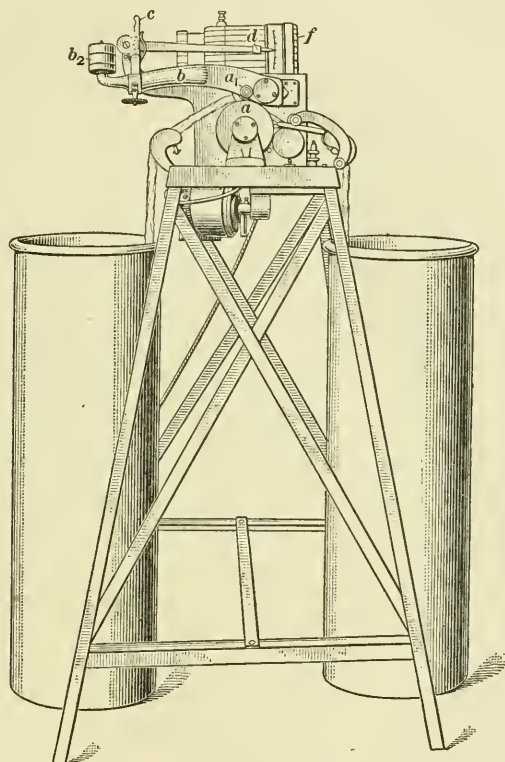

FIG. 13

be tested. A weight acting through a set of levers compresses the sliver as it passes between the rolls. A pen carried on one of the lever arms records the degree of compressibility in the sliver and, consequently, the variation in sliver evenness on a traveling chart.

While this instrument is designed primarily for testing card and drawing sliver, it is also used extensively for the testing of

roving. By means of it many varied, interesting, and highly beneficial experiments can be conducted. Formerly, when it was desired to determine which of two lots of cotton would operate better in the carding processes and produce the stronger yarn, it was necessary first to make the cotton into yarn. Then, by comparative and breaking tests the better cotton was determined. Much time and expense could have been saved by using the sliver tester. In this case, it would only be necessary to process the cotton through the card or the drawing frame; then, by comparing the charts of each sample of sliver as it is run through the sliver tester, the superior cotton could be ascertained. Generally, uniformity in sliver and roving will, under normal conditions, be carried into the spinning processes, and uniformity in the spun yarn is usually an indication of yarn strength and quality.

Comparative card tests may be run and the sliver tester used to determine which card is producing the highest quality of sliver. Then those cards producing a low-quality sliver should be adjusted to improve the quality of their product. Often it is found that the speed of a card may be increased considerably without reducing the quality of the sliver produced. The tester may also be used to find the correct roll settings for certain grades of cotton and for determining the maximum amount of draft possible without impairing the quality of the roving. In each instance, these determinations may be made quickly and easily with the sliver tester.

33. Construction.—The sliver tester shown in Fig. 14 is equipped with a creel capable of holding two bobbins of roving. This form of creel is used when roving is tested. The creel may be easily removed when card or drawing sliver is to be tested, as shown in Fig. 13. In this case, a can of card sliver is set in a position below that formerly occupied by the creel and the sliver to be tested is threaded through a guide trumpet and a pair of rolls. The large lower roll *a*, Fig. 14, is mounted on ball bearings, and an electric motor, by means of a suitable gear train, drives this roll positively and at a uniform rate of speed. Two grooves of different widths but of the same depth

are cut into the circumference of this roll. One groove is made
wider than the other to accommodate the greater mass of cotton
in card- and drawing-sliver form. Since the sliver is compressed
in the groove under great pressure, the bearings and roll must
be ground very accurately to prevent errors from being intro-
duced. A small roll a_1, also mounted on ball bearings and
ground to the same tolerances, fits into the grooves of the lower
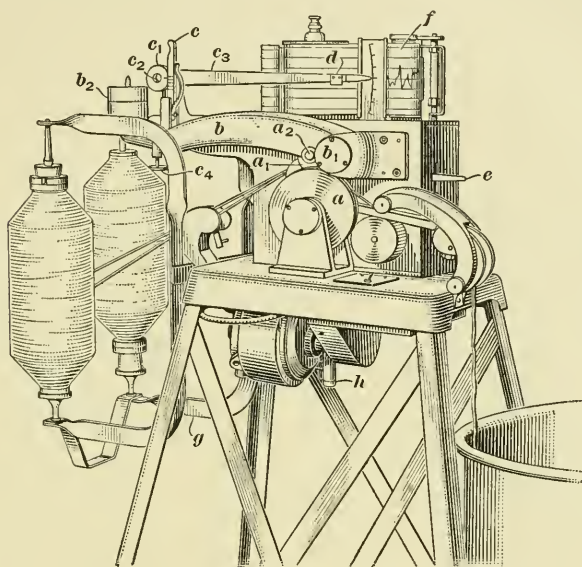

Fig. 14

roll. This roll is constructed in such a manner that two **V**-shaped
disks on its surface mesh with the grooves on the lower roll,
thus eliminating the necessity of changing rolls or the position
of the lever arm every time a change is made from testing sliver
to testing roving or vice versa. The top roll a_1 is held in the
lever arm b by a pin, or shaft, a_2. The lever arm is pivoted at
point b_1 and is therefore free to revolve about this point.

The sliver of cotton is drawn forward by the rolls a and a_1
and is compressed in one of the grooves by means of the weight
b_2 acting through the lever arm b and the roll a_1. Tremendous
pressure must be applied to the strand of fibers to eliminate all
errors that may be caused by foreign particles or other matter

becoming trapped in the strand. Additional pressure is also required, when roving is tested, to nullify the effects of the slight amount of twist in the roving; otherwise, slight variations may be recorded in the roving that are actually caused by twist.

A variation in cross-sectional area and hence variation in weight of the sliver as it is slowly drawn forward by the rolls will result in the raising or lowering of the top roll a_1 and, consequently, of the lever b. An upright rack c is carried at one end of the lever b and is held in mesh with a partially notched disk c_1 by a spring. The disk is pivoted at point c_2, and a small capillary pen d is carried at the end of the arm c_3, which is attached to the disk. Motion imparted to the arm b by the sliver will either raise or lower the rack, which, in turn, tends to impart motion to the disk c_1. The disk will cause the pen arm c_3 to revolve around its pivoted end at c_2, thus raising or lowering the capillary pen.

The sliver tester is constructed in such a manner that any movement given to the top roll a_1 is multiplied 100 times at the pen; therefore, for each .001 inch the top roll moves, the pen will move .1 inch. The movement of the pen is recorded on a paper chart, which is drawn behind it at a uniform rate of speed. The resulting chart is a continuous line plot of the sliver variations recorded in thousandths of an inch. The mechanism for driving the chart is so arranged that by moving the lever e the speed at which the chart is wound on the spool f may be varied. One speed records the variations of 1 inch of sliver over a distance of 1 inch on the chart, while the other speed records the variations in 1 yard of sliver over a distance of 3 inches. A constant-speed electric motor provides a steady, uniform flow of power to the sliver tester. An extension cord attached to the motor makes it a portable unit and allows the tester to be moved throughout the mill. In this manner, tests may be made under the same temperature and humidity conditions as are used in processing the sliver. All exposed parts of the sliver tester are made of stainless steel to prevent the formation of rust particles on the working parts, which would likely produce errors.

34. Operation.—The sliver tester was designed primarily to test card sliver or roving up to about 1.5 hanks in size; therefore, whenever it is desired to test finer roving, slight changes must be made. A trumpet with an orifice of about $\frac{1}{8}$ inch in diameter is used for testing card sliver and coarse roving. When small roving is to be tested, a trumpet with a $\frac{1}{16}$-inch orifice is usually used. The large trumpet is placed in such a position as to guide the card sliver into the wide groove on the lower roll, while the smaller trumpet, when roving is tested, is placed over the small groove. The variation in groove width is necessary to maintain the same degree of sensitiveness in readings when card sliver or when roving is being tested. If a small strand of roving were to be placed in the wide groove, it would be compressed into so thin a strand that variations would be hard to detect. Both of the weights b_2, Fig. 14, are required on the weight arm, when sliver is tested, to provide the correct degree of sensitivity, but only one weight is required when roving is run.

The lever controlling the speed of the chart is moved to its central, or neutral, position. This motion disengages the clutch and prevents the chart from being drawn forward by the take-up roll. The capillary pen is filled with a special ink used for such purposes and is adjusted to come in contact with the chart. A long twisted point is made on the sliver to facilitate threading through the trumpet. The rack c, Fig. 15, is held to one side, thus disengaging the disk c_1 as the motor is started. The lower and top rolls a and a_1, Fig. 14, as they revolve, draw the sliver forward. The arm b and the rack will rise as the sliver passes between the rolls. The rack should not be released until the pen is held at the center of the chart. This makes all calculations in connection with the charts simpler. A fine adjustment in the form of an adjusting screw c_4, Fig. 15, is provided to bring the pen to the approximate center of the chart.

While the motor driving the tester is in operation, the lower roll a, Fig. 14, is revolving slowly and at a uniform rate of speed. The pen arm and the pen will, therefore, rise and fall as the sliver passes beneath the top roll. No record of sliver variations will be made until the mechanism driving the chart is set in

motion. The chart is started by moving the lever e downward. This lever engages a clutch that draws the chart forward at a rate of 3 inches for every yard of sliver passing through the tester. If it is desired to record the sliver variation inch for
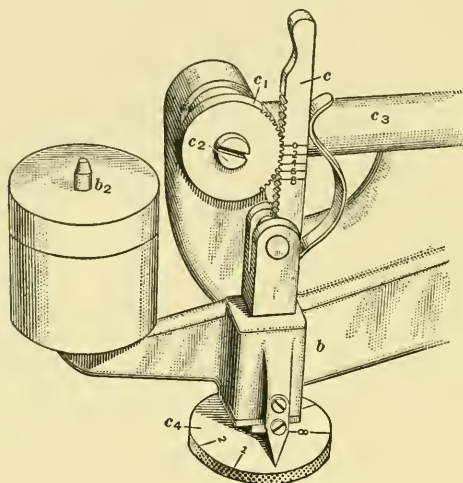

FIG. 15

inch on the chart, that is, plotting 1 inch of chart for every inch of sliver passing through, the speed of the chart is increased by pressing the lever e upward. Where variations in long lengths of sliver are to be recorded, it would be impracticable to run a unit-for-unit plotting.

The operation of the sliver tester is practically the same when tests are run on fine roving. In this case, the special roving creel shown in Fig. 14 should be used. When roving of 1.00 hank or finer is to be run, two bobbins of roving should be placed in the creel, one being placed upside down to enable the rovings to be drawn side by side from the bobbins. When coarse roving is used, one bobbin is all that is necessary and this may be set in the center of the creel. The small $\frac{1}{16}$-inch trumpet and the small groove should always be used for roving, together with one weight on the weight arm.

35. Charts.—A typical sliver-variation chart made by the sliver tester is shown in Fig. 16. This chart is sometimes termed

an inch-by-inch chart because the variation in each inch of sliver passing through the tester is recorded on a distance of 1 inch on the chart. Therefore, each heavy vertical division spaced 3
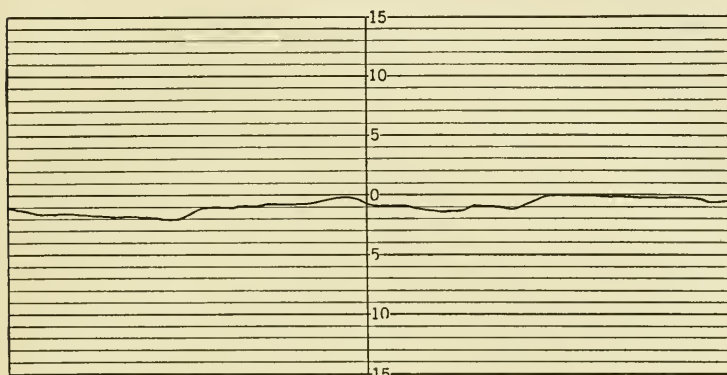

FIG. 16

inches apart on the chart will represent 3 inches of sliver. The chart is divided into other vertical divisions, very light lines being spaced 1 inch apart. These light lines are of no consequence other than to indicate a space of 1 inch on the chart.

FIG. 17

Every third line is heavy, to represent a length of sliver equal to 3 inches. Another form of chart used is shown in Fig. 17. In this case, the variations occurring in 1 yard of sliver are

recorded in a space of 3 inches; therefore, each heavy vertical line now represents 1 yard of sliver. These charts may be readily distinguished from each other only by the characteristic line plotted. An inch-by-inch chart has a plotted line that is quite smooth, with gradual changes or trends in direction, as shown in Fig. 16. The regular chart usually made in most test runs records a yard of sliver in 3 inches of chart length. Thus, the variations found in 1 foot of sliver must be crowded into a space 1 inch long on the chart. The result is a plotted line that is very rough and irregular as shown in Fig. 17.

The same chart paper is used when either of the two forms of charts is plotted, the only difference being in the speed with which it is drawn past the pen. The chart paper is divided by light horizontal lines spaced .1 inch apart. Each horizontal division will, because of the construction of the tester, represent a variation of .001 inch in the sliver tested. Every fifth horizontal line is a heavy line to help in reading the chart. The center line is also drawn heavy and is marked *0*. The heavy lines above or below this center line are marked in the following order: *5, 10,* and *15.* Therefore, a line marked *5* and located above the center line indicates that the sliver at this point is .005 inch thicker than the thickness of the sliver desired, and a line marked *5* and located below the center line represents a sliver variation of .005 inch in lightness.

36. Evaluation of Charts.—The charts made by the sliver tester may be evaluated in several different ways, depending on the type and amount of data to be derived from them. The simple comparative method may be used when it is desired to compare the effects that different machines, or even different processes, have on a sliver. In this case, the charts obtained by running the sliver from each machine through the tester are laid side by side. It should be noted whether the variations are erratic or tend to follow a definite sequence.

Charts showing sliver or roving variations show a tremendous difference in the variations plotted for different processes. Generally, a card will produce sliver showing the least variation inch for inch. The supposition that this also applies to yard-for-yard

variations is false, because yard for yard, card sliver shows a great variation. A chart showing card sliver inch for inch is shown in Fig. 16; the evenness and smoothness of the plotted
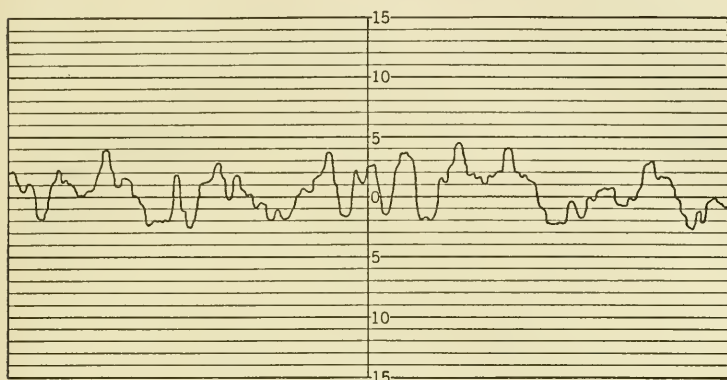

Fig. 18

line should be noted. Another card-sliver chart showing the same sliver plotted yard for yard is given in Fig. 17 for comparative purposes.
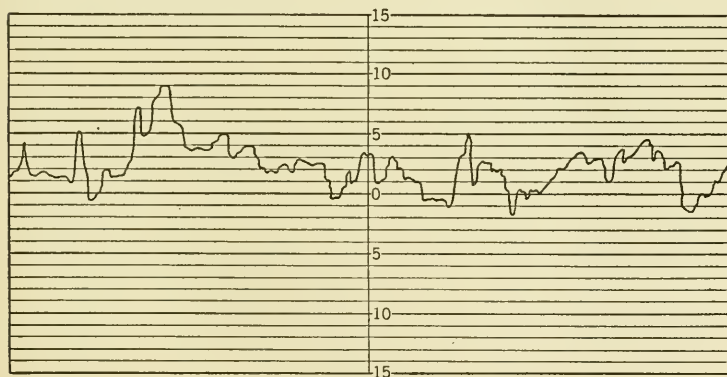

Fig. 19

A first drawing-frame sliver chart is shown in Fig. 18. The irregularity of the plotted line should be observed and compared with the plotting of the card sliver in Fig. 17. In this case, the variations in the drawing-frame sliver, inch for inch, are much

greater than in the card sliver, but the variations in the drawing-frame sliver, yard for yard, remain fairly even. The same difference in sliver variation also applies to the second drawing-frame sliver.

Slubber roving, yard for yard, generally shows the greatest variation of any process. This tremendous variation, as shown in Fig. 19, is caused largely by the lack of doublings at this process. When the same slubber roving is doubled at the intermediate fly frame, a remarkable evenness in sliver thickness is
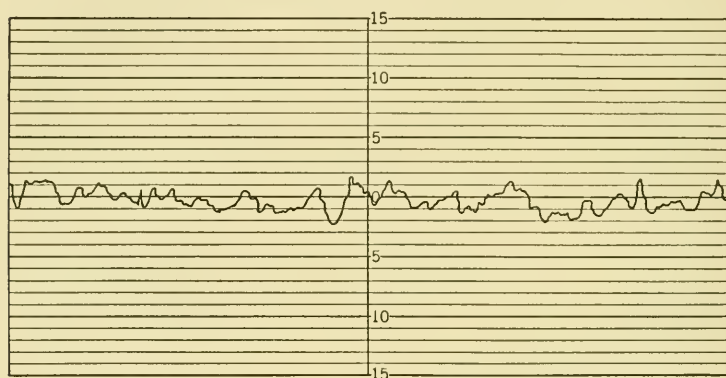

Fig. 20

obtained as shown in Fig. 20. Thus, as the cotton is processed, the resulting roving tends to become more even and uniform, yard for yard, owing to the doubling processes employed.

37. The comparative tests described are of use when comparing different kinds of cottons and different processes. When the utmost value is to be realized from the sliver charts, other forms of evaluating the charts should be used. Much valuable data may be obtained from the charts by means of mathematical evaluations; for example, the maximum variation occurring in the total length or in any given length of the sliver may be found; the average variation per yard of sliver, an indication of sliver evenness, may also be determined.

38. Average Thickness of Sliver.—The first calculation normally made in evaluating a sliver chart is the determination

of the average thickness of the sliver. The adjusting screw c_4, Fig. 15, for making fine adjustments in the initial position of the pen on the chart has its circumference divided into ten divisions. One complete revolution of the adjusting screw will raise the rack c and, consequently, move the pen a distance of .01 inch; therefore, each division on the adjusting screw represents .001 inch, which is in reality a measure of the space between the two rolls a and a_1, Fig. 14. The rack c, Fig. 15, has a number of notches or teeth cut on its face which mesh with those on the disk c_1. Each notch represents .01 inch and alternate notches are numbered. Therefore, the notch marked 6 would represent .06 inch, while the notch between 6 and 8 will indicate .07 inch. When the notch on the disk and the line marked 0 on the rack are opposite each other, the roll a_1, Fig. 14, fitting into the groove on the lower roll a, will be resting on the bottom of the groove.

As the sliver tester is started and the sliver is threaded between the rolls a and a_1, the rack c, Fig. 15, is held out of mesh with the disk c_1, thus disconnecting the linkage between the rolls and the recording pen. The sliver will cause the top roll to rise and fall, carrying with it the lever arm b and the rack c. The pen is held at the height equal to the center line of the chart and the rack allowed to engage with the gear. The machine should be stopped and the pen brought to the center line by means of the adjusting screw c_4. A reading is taken to determine the thickness of the sliver. The number of the line on the rack opposite the notch in the gear is read. For example, this number may be 4. The division on the adjusting screw under the pointer shown in Fig. 15 is noted. If this number is, say, 9, the thickness of the sliver will be read as 49 or, expressed in inches, would be .04 inch plus .009 inch, or a total thickness of .049 inch. This figure represents the average thickness of the sliver or the distance the rolls are held apart by it.

When calculations are made from various chart values it is advisable to make all readings in plain figures and to dispense with fractions of an inch. For example, in reading the average thickness of the sliver it is much easier and simpler to read 49 than it is to change it to its correct unit, .049 inch.

39. Maximum Variation in Sliver Thickness.—The maximum variation in thickness of a sliver is found by counting the number of lines between the highest and the lowest points of the plotted line on the chart. Actually, this is finding the difference in thickness of the sliver, or the maximum variation of the sliver between its thickest and thinnest point. For example, the maximum peak of the plotted line rises to the seventh line above the center line and the lowest point is 3 lines below the center. As each line, while spaced .1 inch from adjacent lines, represents a variation of .001 inch, the total variation in this case would be .007 plus .003, or a maximum variation of .010 inch. This may be expressed simply as 10.

40. To find the maximum variation in a length of roving, expressed in percentage:

Rule.—*Divide the maximum variation by the average thickness and multiply the quotient by 100.*

EXAMPLE.—The average thickness of the sliver shown in Fig. 18 was found to be .050 inch, or 50, and the maximum variation to be .0075 inch, or 7.5. What is the maximum variation expressed in percentage?

SOLUTION.— $\dfrac{7.5 \times 100}{50}$ =15 per cent maximum variation.   Ans.

41. Average Variation.—The sliver charts may be utilized to their greatest extent when a reliable index is used to designate the uniformity of the sliver. The thickness of a sliver corresponds to the weight of that sliver, but this value is useless as a check on sliver evenness unless it is taken at a definite number of points. The maximum variation in sliver weight corresponds to the maximum variation in sliver thickness. This value also has little use as an indication of sliver evenness because, in many instances, the sliver may be excessively thick in one place, while throughout the rest of its length the thickness may not vary greatly. Under such conditions a true indication of sliver uniformity is not obtained.

The thickness of a sliver generally varies unit for unit of length. Undoubtedly the plotted line showing the variations in thickness of the sliver will always tend to vary as shown in Fig. 16. The

line may first tend toward the heavy side, then toward the light side, but always shows a tendency toward unevenness. Therefore, at one point the sliver might be thick, or heavy, and at another point a few inches away it might be thin, or light. By averaging the variations in thickness of the sliver over short units of length, the average of the variations in the sliver is obtained. This gives a true indication of the sliver variation in thickness and, therefore, serves as a measure or an index of approximate variation and unevenness of the sliver.

42. To find the average variation per yard of sliver, in percentage:

Rule.—*Multiply the sum of the maximum variations per unit of length by 100 and divide the result by the product of the length of the sliver multiplied by the average thickness.*

EXAMPLE.—Find the average variation, in per cent, in a card sliver 5 yards long having an average thickness of 50 thousandths of an inch, the maximum variation in the sliver yard for yard, expressed in thousandths of an inch, being as follows: 5.5, 4.8, 6.0, 5.8, 5.

SOLUTION.—
$$
\begin{array}{r}
5.5 \\
4.8 \\
6.0 \\
5.8 \\
5.0 \\
\hline
27.1
\end{array}
$$

$\dfrac{27.1 \times 100}{5 \times 50} = 10.84$ per cent average variation. Ans.

43. Evaluating Results.—An excellent indication of sliver evenness is obtained by comparing with the average variation, the figure obtained by subtracting the average variation from the maximum variation. This form of test is useful in evaluating the results obtained from running a sliver test on two different grades or kinds of cotton, or it may be used for determining the best settings and the correct drafts to use with certain lots of cotton.

The percentage of maximum variation represents the extreme or the maximum variation occurring in a given length of sliver.

The percentage of average variation represents the average of the maximum variations occurring at definite units of length in a number of yards of sliver. The ideal sliver would be one having the average variation and the maximum variation equal to zero or having the values of these two equal to each other. The sliver would then have absolutely no unevenness. While this ideal state is unattainable, it is highly desirable to have the average variation almost equal to the maximum variation. Therefore, as the difference between these two values diminishes, the sliver evenness will increase.

For example, a test run was made of two lots of cotton at the card. A maximum variation of 20 per cent and an average variation of 10 per cent were found in the sliver of the first lot of cotton. The second lot of cotton showed a maximum variation of 23.5 per cent and an average variation of 10.7 per cent. The difference between the two values in the first case would be 10 and in the second case 12.8. The cotton in the first lot would, undoubtedly, produce the superior yarn because the sliver is the more even.

Card sliver ordinarily shows a maximum variation of about 20 per cent and an average variation of about 10 per cent. These percentages are only approximate and do not apply to every card sliver. One sliver may show a great variation and its percentages may greatly exceed those here given, or it may be exceptionally even and show only a slight variation. When the card sliver having the variations listed is made into roving at the slubber the maximum variation will be about 65 per cent and the average variation about 50 per cent. While the magnitude of the slubber variations greatly exceeds those of the card sliver, it is often concluded that the card sliver possesses the greater uniformity because the difference between the maximum and the average variations is 10 as compared to a difference of 15 in the roving. But this is not the case. While the difference between the maximum variation and the average variation in the card sliver is 10, this difference is equal to the average variation. With the slubber roving, the difference is 15, but this is three-tenths of the average variation. Therefore, this would tend to indicate that the slubber roving is much more even than the card sliver.

The high percentage values obtained for the slubber roving are by no means an indication of roving unevenness. The variations in thickness of the roving expressed in thousandths of an inch remain fairly constant throughout most of the roving operations, but the thickness of the roving is constantly being reduced. As the roving becomes smaller in size because of successive processing operations, the variation percentages will tend to increase in magnitude. As a result, the average and the maximum variations tend to increase in magnitude but to approach each other in all operations succeeding the slubber. Thus roving of greater uniformity is produced. The variations in the slubber roving which, in most cases, are the largest found in the roving at any operation, are undoubtedly caused by the lack of doublings. The use of doublings in roving in the succeeding roving operations tends to increase the uniformity and the quality of roving.

CARDING STAPLE RAYON

PREPARATION OF STAPLE RAYON

44. Staple Rayon.—Staple rayon, cut staple, rayon staple or cut rayon, as it is often called, consists of short lengths of rayon filaments. Practically the only difference between staple rayon and filament rayon is the length of the fibers. Although rayon was first developed and used in continuous filament form, decisive advantages are obtained by using it in short lengths. The fiber in this form is often mixed with cotton and used to produce a yarn or fabric of new characteristics, or it may be mixed with wool for the purpose of simulating wool or to produce a fabric with entirely different features. Often it is mixed with silk, or in many cases, with several or all of the other natural textile fibers. A field of novel and varied fabrics possessing characteristics that were previously impossible to obtain with the usual animal and vegetable fibers has been created with the use of cut-staple synthetic fibers.

Generally, staple-rayon fibers are produced from rayon manufactured by the viscose, the acetate, or the cuprammonium process. Viscose, because of its lowness in price, leads the staple field in production, with acetate staple second. The

length and the size, or denier, of the fibers used may be varied, depending on the system of yarn manufacture employed, the fabric for which the yarn is intended, the handling qualities, and the appearance of the desired fabric. Staple rayon is usually obtainable in lengths varying from 1 to 6 inches. Staple lengths of $1\frac{1}{2}$ inches or 2 inches are commonly used in cotton mills and are well adapted to cotton-mill machinery. Three different degrees of luster or brightness of staple are made, the usual classification being bright, semidull, and dull. The most popular denier sizes of staple rayon are $1\frac{1}{2}$, 3, and $5\frac{1}{2}$ denier.

A $1\frac{1}{2}$-denier rayon fiber is approximately equal to the diameter of a cotton fiber and is therefore best suited for mixing with cotton, while a 3-denier nearly corresponds to the diameter of a fine wool fiber. The use of fibers other than the $1\frac{1}{2}$-denier filament is by no means excluded from use on the cotton system. On the contrary, coarse deniers find extensive use in various cotton blends. Because of their coarseness and lack of adhesive qualities, however, it is not advisable to spin yarns of cotton and rayon blends finer than 20s from 5-denier staple, and not above 30s when a 3-denier staple-rayon fiber is used. Spun-rayon yarns made from $1\frac{1}{2}$-denier staple may, however, be spun to counts closely approximating those commercially advisable to spin with cotton, 120s generally being the limit.

45. Manufacture of Staple Rayon.—Formerly, practically all staple rayon was produced by cutting rayon waste made in the various processes of rayon-yarn manufacture. Because of the tremendous demand for staple rayon, several methods of manufacture were developed. Briefly, one method consists in producing the long continuous filaments of rayon in the usual manner and then cutting them while in strand form. Another procedure sometimes followed is to cut the rayon filaments shortly after they are formed and before they have been processed and bleached.

Cellulose, the basis of rayon, is usually obtained by digesting wood in pulp form, cotton linters, straw, or other vegetable materials which contain large quantities of cellulose. The digested solution is forced in viscous form through the holes in

a spinneret, that is, a cap having a large number of small holes in its top surface. The fine filaments pass directly from the spinneret into a coagulating bath, where they are solidified, or hardened. Tension is applied to the filaments to keep them of even and uniform thickness as they are drawn through the bath. The rayon, in continuous form, is passed through various bleaching processes and is finally wound on bobbins or cones, or reeled in skein form for shipment.

Often, the cutting of the rayon filament is done at the mill, especially when a large variety of spun-rayon goods is manufactured. In such cases a large supply of staple of varying lengths must be kept on hand to meet the requirements of different orders. Some mills use a staple cutter to cut the continuous-filament rayon into staple of the desired length. A large number of continuous filaments are gathered in strand form and run through the staple cutter. Generally, these machines may be regulated to cut the rayon in lengths varying from .2 inch to 6 inches, and in some cases, to lengths as great as 19 inches. When rayon is cut in staple form at the rayon plant, the use of a spinneret having a greater number of holes than is normally employed results in the production of a much larger strand, which is usually cut after the rayon has passed through the last stage of processing.

Another method of producing staple rayon at the point of manufacture consists in cutting the continuous filaments as they leave the spinneret. The filaments, as they are cut, float in the coagulating bath and are gently moved toward a conveyor that carries them to the various processing operations. This method often tends to cause the fiber to wrinkle or curl owing to the lack of tension on the fiber during its solidifying period. The curl greatly resembles that found in wool, therefore the fiber is largely used in wool mixes.

MIXING STAPLE RAYON

46. Mixes.—Staple rayon is mixed with other fibers, both animal and vegetable, to produce numerous different effects. First, the object of the mix may be to impart to the resulting fabric certain desired qualities or characteristics which it would

be impossible to obtain otherwise. Rayon may be mixed with cotton, with wool, with silk, or with practically any other fiber to impart the desired quality. It may also be mixed with cotton for the purpose of producing a much softer, richer-feeling cloth. In other instances, it may be mixed with wool of the same staple length and spun on the cotton system to produce a soft, fine cloth having all the characteristics of wool, but at a much lower cost. Second, color may be of paramount importance. The correct color texture depends on the careful blending of certain amounts of dyed staple rayon with fiber of some other color. Third, staple rayon may be mixed with various other fibers for the purpose of combining a fine texture in the cloth with a desired color blend. In this manner, the cloth will have certain well-defined properties of handle which are otherwise obtained only through the blending of several other fibers.

Mixing of different fibers to develop desired yarn qualities when color is not of prime importance may be easily carried out. The mixing, or blending, of a small quantity of one kind of fiber with another may be best done at the drawing frame. Each lot of stock is processed separately through all the operations to and including carding. Slivers of each kind are set behind the first drawing frame in the same ratio as that required to produce the desired results. The multiplicity of doublings in the drawing and roving operations results in a uniform and well-mixed blend. When the different kinds of fibers are to be mixed, or blended, in about equal portions, the blending may be best carried out at the picker. Equal lots of well-operated stock may be laid out and fed into the one-process picker.

47. Color Blends.—The blending of color is a difficult problem. Unless great care is taken, the color of various batches will vary, and in some instances one batch may appear mottled, or streaked.

It is generally advisable, whenever large percentages of colored stock are to be blended, to process each color separately at the picker. Color work may be best processed when two- or three-process picking is employed. The laps from the breaker or the intermediate picker are set up at the finisher picker in a color

ratio according to the percentage of each color desired. Only the minimum amount of picking and beating action necessary to form a good lap should be employed. Otherwise, serious fiber breakage is liable to result, especially with rayon. In determining the number of laps of each color to use at the finisher picker, allowance should be made for the amount of cotton lost in the various cleaning operations through which the stock must pass. For example, if the final blend is to contain 40 per cent of cotton of a certain color, the laps of cotton must be made slightly heavier to compensate for the amount of waste removed in various processing operations.

This method of blending cannot be employed successfully when small percentages of color are to be used. In such cases, the blending is best carried out at the drawing frames in the same manner as for mixing small amounts of different fibers. The addition of an end or two of colored sliver at the first drawing frame usually insures excellent color blending, especially when light shades are to be produced.

<div align="center">CHANGING CARDS FOR RAYON</div>

48. Mechanical Changes. — Several slight mechanical changes are necessary on cotton cards for their successful operation on staple rayon. Many mill men vary in their opinion as to what mechanical changes may be termed necessary. Undoubtedly, this difference in opinion is caused by the varying conditions existing in individual mills and the specific problems encountered.

The use of solid screens under the licker in place of the mote knives and, in other instances, the use of solid screens under the main cylinder have been recommended by some mill men. In the estimation of others, solid screens should not be used but the regular mote knives and cylinder screens retained. Generally, if solid screens are used, the card would tend to throw much fiber out the side of the screen, thus defeating the purpose of the screens. The regular screens, when retained, are set as close as possible to reduce the amount of lint produced.

Carded staple rayon is often hard to remove from the doffer in web form. Unless exact control is maintained over tempera-

ture and humidity conditions, the web will sag. A temperature of about 70 degrees Fahrenheit and 55 per cent relative humidity should obviate this defect. When the web fails to respond to this treatment, the stroke of the doffer comb should be raised. Another remedy is to increase the speed of the calender rolls from 2 to 3 per cent. Some mills have installed smooth metal pans or guides to support the web in its passage from the doffer to the calender rolls. Ordinarily, this is not necessary unless acetate rayon is being carded, and then it is desirable because of the weakness of the web. A mill making use of 3-denier or heavier staple rayon may find it expedient to use a pan because of the lack of adhering qualities in the coarse staple.

It is advisable to return the flat strips to be reworked whenever possible. The return of this rayon fiber to the card greatly reduces losses caused by waste, but this return is not practical on the finer counts or the higher quality of work. The return of flat strips in lower-quality work may be easily accomplished by removing the flat-stripping comb and placing it at the back of the card above the entering lap of cotton. A small curved metal plate placed beneath the stripping comb will allow the flat strips to drop on the lap of cotton being fed.

49. Settings.—Staple rayon is usually carded efficiently when the card settings used for a good grade of cotton are maintained. It is difficult to give hard and fast rules as to the card settings to use on rayon work because of the many varying factors that must be considered, such as, the class of goods the stock is to be used in, the staple and the denier of the rayon, the counts of yarn to be spun, and the condition of the card.

A few general settings are practically all that may be recommended. For example, the feed-plate should be set as close as possible to the licker. While this distance will depend, to a certain extent, on the type of feed-plate used, the short-nosed plate should be set about .015 inch from the licker and the long-nosed plate about .010 inch from the licker. The speed of the licker should be kept to about 320 revolutions per minute and should not exceed 400 revolutions if the minimum amount of fiber breakage is to be had. The screen around the main cylinder

should be set as close as possible to minimize the amount of fly removed. The normal cylinder speed of about 165 revolutions per minute is maintained.

The flats should be raised to reduce the percentage of waste removed, because the main function of carding rayon is principally that of parallelizing and straightening the fibers. The flats should always be run at the lowest speed, usually about 1 inch a minute and, in some instances, the direction of rotation of the card flats is reversed to reduce further the amount of flat strips. The front knife plate is set as close to the cylinder as possible in an effort to reduce the flat strips. Ordinarily, the flat strips will not exceed 2 per cent of the stock fed.

Generally, the speed of practically all revolving parts of the card should be reduced and all settings and adjustments made to remove the least amount of fiber possible. The use of normal speeds in a card would tend to increase fiber breakage in many cases. Much attention should be given to humidity and temperature control. A temperature of about 70 degrees Fahrenheit and a relative humidity of 55 to 60 per cent is usually satisfactory. If the humidity exceeds this figure, the card may load down with embedded fibers and frequent stripping will be necessary. A humidity below 55 per cent usually results in difficulties caused by static electricity.

Date Due